ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Vol. XXXI, No. 13.

TABLE OF CONTENTS.

ENGINEERING NEWS OF WEEK.....251, 260, 268
Railway Development and Commerce in the Republic of Colombia (illustrated)..... 252
Drinking Waters at the World's Columbian Exposition 252
Frostproof Mortars..... 253
Dixon's Automatic Fog Signal Apparatus (illustrated 252
Electric Corrosion of Water Pipes in Brooklyn, N. Y..... 255
Carriageway Pavements in Large Cities..... 256
The Water Meter System of Lexington, Ky. (illustrated) 258
Sulzer Triple-Expansion Vertical Engine (with inset) 259
Borings for the Boston Subway..... 260
Failure of a Masonry Frame in a Water Power Electric Light Station (illustrated)..... 265
Legal Decisions of Interest to Engineers..... 265
La Grange Dam for Turlock and Modesto Irrigation Districts, Cal (illustrated)..... 263
The Pavements of Youngstown, O..... 266
Deflection of Track under Moving Trains (illustrated) 266
Compound Locomotive, Pennsylvania R. R. (illustrated) 267
Cutting a 20-in. Water Main in Place (illustrated) 267
The Prospects for a North River Bridge..... 267
Canal St. Sewer, St. Paul, Minn. (illustrated).. 268
PERSONALS, NEW PUBLICATIONS, SOCIETY PROCEEDINGS 260
EDITORIAL NOTES..... 262
Continuous Rails for Electric Railways—Need for Care in the Installation of Electric Wiring—Cost of Subways for City Streets—A Legal Decision Interesting to Sanitary Engineers—Maneuvring Power of War Vessels.
EDITORIAL:
Abolishing the Coast and Geodetic Survey..... 263
LETTERS TO THE EDITOR..... 263
Errata in "Cleaning and Sewerage of Cities"—Failure of a Canadian Bridge—Comparative Efficiency of Screw Propellers in Water and in Air—Non-Tipping Segmental Bridge Rollers (illustrated)—Responsibility for the Accident on the Knoxville Wire Rope Tramway—The Proposed Virginia Road Law—A Successful Method of Dumping Carts (illustrated)—Field Notes for Beginners on a Surveying Corps—Notes and Queries.
CONSTRUCTION NEWS..... 269
Railways, Street and Electric Railways, Elevated and Cable Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewers, Streets, Electric Light and Power, Contract Prices, Miscellaneous Contracts and Supplies.
INDUSTRIAL NOTES..... 272

The statistics of manufacturers in the 165 cities of the United States having a population of 20,000 and over, in 1890, form the subject of Census Bulletin No. 66. With the exception of mining and quarrying, this return includes every mechanical and manufacturing industry having a product of more than $500 in the census year, which is located in the cities included. As compared with the 100 cities from which similar returns were gathered in 1880, the exhibit would stand as follows:

Number of establishments reporting.....	78,033	167,844
Capital.....	$1,384,879,147	$3,524,334,525*
Average number of employes	1,431,076	2,581,237
Males above 16 years	1,008,196	1,990,332
Females above 15 "	330,059	538,491
Children.....	92,821	52,414
Total wages.....	$555,748,845	$1,400,882,018**
Cost of material used..	$1,910,811,178	$2,992,724,848
Value of product.....	$3,018,413,756	$5,621,258,583

No.e.—*Does not include "hired property." **Includes officers, firm members and clerks and their salaries.

The cost of materials and the value of the products are those at the factory, without allowance for commissions or expenses of selling.

A separate bulletin (No. 67) covers the totals for the above items for the whole United States, and this is compared with the Census of 1880, as nearly as the incompleteness of the earlier census will permit, as follows:

	1890.	1880.	Per cent. of Inc.
Number of establishments	322,624	253,502	27.27
Capital	$6,138,716,604	$2,780,766,895	120.76
Miscellaneous expenses	615,056,643	b	..
Average number of employes	4,476,094	2,700,732	65.74
Total wages.....	$2,171,356,919	$939,462,252	131.13
Officers, firm members and clerks:			
Average No...	426,139	b	..
Total wages..	372,005,001	b	..
All other employes:			
Average No...	4,049,955	b	..
Total wages..	$1,799,351,918	b	..
Cost of material used	5,018,277,603	$3,395,952,123	47.77
Value of products	9,054,435,337	$5,349,191,458	69.27

("b"—These items were not reported in the Census of 1880.)

In the above comparison about 33,000 establishments, returned in 1890, are omitted, as they were not included in the Census of 1880, and can not thus be compared. Including these establishments, the total value of products in 1890 would be $9,370,107,624; cost of materials, $5,158,868,355; total of other employes, 4,250,783; officers, firm members and clerks, 461,049; miscellaneous expenses, $630,944,058; capital, $6,524,475,305. The exact number of establishments reporting was 355,401.

A most interesting feature of the report is that it enables a comparison to be made of different manufacturing industries with respect to their commercial or economic importance. Comparing them on the basis of total capital invested, it is found that iron and steel, lumber and wood products, and the textiles of every class are the three great branches of manufacture which outrank all others. Thus, in round figures, the report shows about $840,000,000 invested in the manufacture of iron and steel, foundry and machine shop products, forgings, nails, pipe, bolts, nuts and washers and architectural iron work. In lumber, planing mill products and timber products not manufactured at the mill, about $680,000,000 is invested; and in textiles, including cotton, woolen and worsted goods, hosiery and knit goods, silk and silk goods and in dyeing and finishing textiles, the investment amounts to nearly $700,000,000. No other branch of manufacture approaches these three in its extent.

The new topographical maps for New York state are making their appearance, and maps covering one-fifth of the state are already issued. This is the survey for which the state appropriated $24,000 and the national government expended an equal amount. The maps issued include the city of New York and its vicinity, Albany, Utica, Syracuse, Rochester, Buffalo, the Niagara River and part of the Erie and all of the Champlain canal systems. The exact area and boundary of every town and village is shown, with roads, railways, water courses, etc., and elevations are indicated by 20 ft. contours. The tourist regions of Watkin's Glen and the Adirondacks are also included. It will take about six or seven years to finish the work in New York state.

The most serious railway accident of the week was a derailment, March 22, at Cartier, Ont., on the Canadian Pacific Ry. The accident was caused by a defective switch, the engine and mail and express car passing in safety, while the three rear passenger cars took the side track, and were derailed and upset. Two men were killed.

A bridge at Milano, Tex., on the Atchison, Topeka & Santa Fe R. R., was broken down by a derailed freight train March 21.—Two of the three spans of a new bridge over the Nation River at Casselman, Ont., were carried away by the ice on March 17, as described more fully in our correspondence columns.

A cyclone caused much damage in the vicinity of Emory and Greenville, Tex., March 18, its path being about 100 yds. wide and two miles long. Ten persons were killed and a number injured.

An explosion of nearly 10,000 lbs. of dynamite occurred March 23 at the works of the Acme Powder Co., Black's Run, Pa. The explosion occurred in the packing house, and four persons were blown to pieces, while another was killed by the fall of the boarding house.

The largest drydock on the lakes is to be built by the Chicago Shipbuilding Co. at Chicago. The dock will be built of wood, with a steel caisson for closing the entrance, and its dimensions will be; length from inner side of gate, 425 ft.; length from center of rudder well, 385 ft.; width of floor, 80 ft.; width of entrance at sill, 50 ft., 12 ft. above sill, 70 ft.; depth of water at sill, 18 ft., over keel blocks, 17 ft. The caisson will be 52 ft. long at keel, 72 ft. long on deck, 13 ft. beam and 25 ft. deep from deck to bottom of keel. The floor of the dock will be 21½ ft. below water, and the rudder well will be 13 ft. deep. The pumping machinery will consist of two vertical, centrifugal pumps, with 30-in. discharge pipes, and a capacity of 25,000 gallons per minute each. The total amount of water to be exhausted at each docking is 6,000,000 gallons. The estimated cost of the dock is $150,000. Mr. Ambrose V. Powell, of Chicago, is the designing engineer.

The new track elevation ordinance which Mayor Hopkins drew up some time ago for the elevation of the tracks of the Lake Shore & Michigan Southern and Chicago, Rock Island & Pacific railways in Chicago, has been passed by the City Councils. The ordinance provides for the elevation of the tracks of these companies upon a metal structure with the depression of cross streets and the construction of the necessary subways. It is thought that the ordinance, possibly with slight changes, will be accepted by the railway companies.

The new garbage collecting wagons adopted in New Orleans are made in two easily detachable and interchangeable parts, a tank and a frame, made all of steel, and weighing about 4,000 lbs. The steel tank has a false or perforated bottom through which all liquids drain, leaving the solid portions separate, and giving it a chance to dry. These tanks are suspended from the steel frame by two sets of chains and windlasses, by which arrangement a loaded tank can be quickly lowered to the ground at the works, or point of deposit, and an empty tank put in place. There is thus no necessity for changing the team. Forty of the wagons are to be used daily in New Orleans, and ten extra tanks are provided. By a new ordinance all householders are required to place all offal, slops, garbage and refuse, animal and vegetable matter in water-tight, covered metallic receptacles. They must place these vessels where the collector can easily get at them, under penalty of $10 fine. Collections are made between 6 and 8 o'clock each morning. The garbage wagons described were made by the Agricultural Works, of New Orleans.

Plans for a bridge across the St. Lawrence River between Brockville, Ont., and Morristown, N. Y., have been prepared by the Union Bridge Co., of New York, and, it is said, have been approved by the Secretary of War. According to reports, the bridge will have the following spans, beginning at the Canadian side: Three 256 ft. and one 672 ft. to the first island; one 256 ft., three 224 ft., one 288 ft., one 224 ft., one 256 ft., one 672 ft., and one 256 ft. to the American shore. The bridge will connect with the Canadian Pacific and Grand Trunk railways on the Canadian side and with the New York Central & Hudson River lines on the American side, and it will provide for both railway and highway traffic. The organizations which have the franchises for building the bridge are the St. Lawrence Bridge Co., in New York, and the Brockville & New York Bridge Co., in Ontario. It is stated that these two companies will be consolidated as the Brockville & St. Lawrence Bridge Co. The total cost of the structure is estimated at $2,500,000, and it will require in its construction 25,000,000 lbs. of iron, 2,000,000 ft. of lumber, 14,000 cu. yds. of stone masonry, and 60,000 cu. yds. of concrete.

The first 13-in. gun of American make was tested at Indian Head on March 21. The first 1,100-lb. projectile was sent off with 403 lbs. of brown prismatic powder, made at the Dupont Works, at Wilmington, Del. The shell was lodged in a sand bank 300 yds. away and had a velocity of 1,720 ft. per second. The second shot had 482 lbs. of powder behind it and attained a velocity of 1,975 ft. per second. The powder made an excessive smoke and a considerable quantity of residuum was left in the gun. The hydraulic carriage apparatus was manipulated readily and without accident. At the same time a test was made of the new Navy smokeless powder, made at the Newport torpedo station. A 4-in. rapid-fire gun was used and two rounds were fired, with remarkably little smoke, not enough to derange the aim or to prevent the rapid working of the gun. There was also a test of a 12-in. nickel-steel Harveyized armor plate. This was first attacked by a 10-in. gun using Johnson cast steel shells of 500 lbs. each, with 240 lbs. of powder at 400 yds. range. The velocity developed was 1,640 ft. per second; the shell penetrated about 4 ins., and rebounded badly shattered, with no cracks in the plate. The second shot, to the left of the center, was with a service, forged steel armor-piercing projectile of 500 lbs., with 240 lbs. of powder. This shot penetrated 5 ins. and left the point imbedded in the plate. The plate was cracked through near the first shot in the upper left hand corner and was seriously damaged.

The lake shaft of the new water-works tunnel at Milwaukee has been sunk to its full depth, having been finished by the city after many difficulties, and the practical abandonment of the work by the contractors, Schaller & Schnigian, of Chicago. In April, 1893, a severe storm damaged the crib, causing the loss of 14 lives and much delay. In September, 1893, great trouble arose from water and sand at a depth of about 110 ft. The contractors offered to finish the work for $250 per lin. ft., but the city concluded to do the work instead. A steel cylinder, it is reported, was put down inside the existing lining and carried down to clay, from which point, it is stated that a brick lining was used. About half of the 3,200-ft. tunnel has been completed, but this work was also abandoned by Schaller & Schnigian, and will probably be completed by the city. Mr. Geo. H. Benzenberg is City Engineer and engineer of the tunnel. The whole project was described and illustrated in our issue of Oct. 25, 1890.

RAILWAY DEVELOPMENT AND COMMERCE IN THE REPUBLIC OF COLOMBIA.

A little over two years ago a company was quietly formed by Mr. S. B. McConnico, who was for many years connected with the Illinois Central Ry., for the purpose of further developing the commerce of the Republic of Colombia, by way of the harbor of Cartagena and the Magdalena River, the great commercial highway of that South American state. A number of the most prominent and reputable capitalists of Boston and New York were enlisted in the project, and they went to work with so little parade that the general public has known little of the enterprise that is now practically an accomplished fact. For the map here used and for the general information concerning the purposes of and the work accomplished by this company we are indebted to the courtesy of Mr. McConnico, who supplied these data at our especial solicitation.

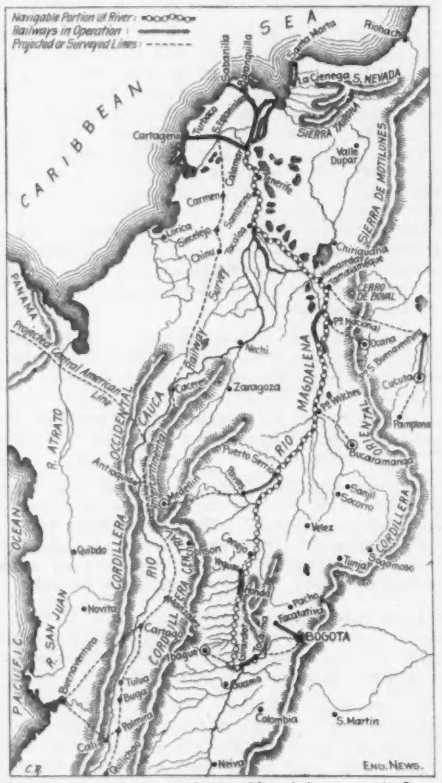
The company referred to was originally organized to construct a line of railway connecting the magnificent harbor of Cartagena with the Magdalena River at Calamar. Work was commenced in March, 1892, and will be completed in June of 1894. The length of the line is 65 miles, and the elevation overcome in that distance is a little less than 600 ft. above tide, between Cartagena and the Dique River. At Calamar the line again descends almost to ocean level.

The purpose of this railway is to form a connecting link between the already large commerce of the interior of Colombia, which is largely tributary to and comes down the Magdalena River, and the harbor of Cartagena, not only the best harbor on the northern coast of Colombia, but also one of the finest in the world. Cartagena is a city of over 20,000 inhabitants, and is the seat of government of the Department of Bolivar, and the railway connecting it with Calamar passes through a well populated and exceedingly productive section of the country, which will furnish a paying local traffic, aside from the through traffic from the interior. The Cartagena Terminal & Improvement Co., Ltd. (the formal name of the company whose work is described in this article), has secured from the Colombian Government the exclusive right, for a long term of years, to construct, own and operate wharves and terminal facilities in the harbor of Cartagena. Under this contract it built, and had in operation in May last, a substantially constructed deep-water wharf, with a minimum depth alongside of 30 ft., which is capable of accommodating at one time five steamships of the deepest draft. In addition to this wharf the company has already provided commodious warehouses and superior facilities and conveniences for handling freight economically and expeditiously. The harbor itself is easy of access, perfectly landlocked, and the anchorage ground is unusually good. The entrance channel is broad, and has been well marked, within the year, by 18 modern tripod beacons. The city of Cartagena is healthy, absolutely free from epidemic or contagious disease, and the average maximum temperature is 82° Fahrenheit.

The significance of this initial enterprise by American capital in Colombia will be better understood by a glance at the map and a study of the physical and commercial conditions of the interior. It will be seen that Colombia is divided by the three principal ranges of the Andean Cordilleras, known as the Occidental, the Central and the Oriental, running north and south and more or less parallel each to the other. The largest division of Colombian territory lies between the Oriental and the Central ranges, between which flows the great Magdalena River, whose fertile valley and adjacent mountain slopes and plateaus, watered by innumerable smaller streams, contain more than half the population and enjoy fully two-thirds of the commerce of the entire republic. This means a population of more than 2,000,000 of people and a commerce of more than $20,000,000 per annum. This vast region is rich in all precious metals, in coal, iron, copper, zinc, emeralds, cabinet woods, dye woods, rubber, vegetable ivory, medicinal products, etc.; it is a large producer of coffee, tobacco, fruits, sugar cane, wheat, corn, cacao—in fact, all the wealth-producing and life-sustaining agricultural products—and is a large consumer of all classes of foreign manufactured goods.

The Magdalena River is navigated without interruption from a point just inside the delta at its mouth to Las Yehuas, about 650 miles. At the latter point, and for a few miles above, occur some rapids in the stream, around which there exists a little road known as the Dorada Railway, 16 miles long, by means of which connection is made with the river above, where it is again navigated for something over 200 miles, thus making between 850 and 900 miles of navigated river. The class of boats operating on this river are similar to the Ohio and Mississippi river stern-wheel steamers; and although there is much room for improvement in the methods of operating them, they still suffice for the present needs of the commerce. The total number of boats is about 30, and all do a profitable business.

The bulk of the population and trade is located at varying distances from the river, from 50 to 100 miles, and is congregated about certain distinct trade centers, marked on the map, from whence it finds its way by mule trains to the river. These trade centers, mentioned in their order of importance, are Bogota, the capital of the republic; Medellin, the capital of the Department of Antioquia; Bucaramanga, the capital of the Department of Santander; Ocana, an important town, also in Santander, and Ibague, the capital of the Department of Tolima. Another very important trade center and the largest coffee-producing section in Colombia is the city of Cucuta, near the Venezuelan border, whose commerce now finds its outlet and inlet by way of the Gulf of Maracaibo, but which is destined in the future to be connected by rail with the Magdalena and contribute its quota to the carrying trade of that river and to the commercial importance of Cartagena.



Map of the Valleys of the Magdalena and Cauca Rivers, Republic of Colombia, Showing Line of Cartagena-Magdalena Ry., and Other Proposed Connections with the River Service.

It is the manifest destiny of the country that in the near future all these trade centers will be tied to the Magdalena by rail lines, the effect of which will be to largely augment the output of productions, now greatly restricted by the expense, delay and damage incident to mule transportation over rough and at times almost impassable trails. The aggregate length of these lines will not exceed 550 miles, and the amount of capital necessary to construct and equip them will be insignificant compared to the great results to commerce that would inevitably follow. Judging from the cost of several short lines already built in different parts of Columbia and from the estimates made by the engineers of the Inter-Continental Railway Commission, it may be assumed that the average cost of these lines to build and equip will not exceed $30,000 per mile.

The Government of Colombia is earnestly interested in promoting railway development, and at its last session of Congress, in 1892, passed a general railway law authorizing the Executive to aid the construction of desirable lines to the extent of $16,000 per mile, gold, payable in bonds, which are to be receivable in payment of import duties to the extent of 10 per cent. of the total duties, and also by grants of public lands, exemption from all forms of taxation and import duties on materials and supplies. This substantial aid would reduce the cost to investors to a net sum of say $14,000 per mile, and would insure satisfactory returns upon the capital invested. The present government is especially favorable toward American enterprise and capital, whenever presenting themselves through properly accredited and reputable representatives.

Another most important factor in the future of Colombia as a field for railway building, and of Cartagena as an important commercial seaport and railway terminus, is the fact that whenever the South American system of the Inter-Continental Railway becomes an accomplished fact (and in time there is no doubt of this) it must of physical necessity, as well as by superior advantages, find its outlet and terminus at Cartagena. Indeed, the surveys made under the direction of the Inter-Continental Railway Commission have already selected Cartagena as the northern port, and the preliminary line has been run to that point. This Inter-Continental line will not follow the valley of the Magdalena, for physical reasons, but after leaving Cartagena will traverse what are known as the Plains of Bolivar, then enter the valley of the Cauca, the Magdalena's principal tributary, and find its way southward to Ecuador and Peru between the Occidental and Central ranges of the Cordilleras.

Such a line will not materially interfere with the trade now tributary to the Magdalena River, being shut off from that region by the central range of mountains, so that the Magdalena is destined for many years to come, if not for the next century, to continue to be the basis of transportation for all the territory now tributary to it, and for as much more as will be opened up by railway feeders that may hereafter be constructed. It has not been considered necessary in this article to lay stress upon the development of the mineral wealth of Colombia, but it is safe to say that when railway facilities are created and the mining regions of the territory placed in easy connection with the sea coast, there will be an immediate and vast influx of gold seekers, for the past record of Colombia as a gold producer is not excelled by that of any country in the world.

DRINKING WATERS AT THE WORLD'S COLUMBIAN EXPOSITION.

By Allen Hazen.*

The number of different waters used for drinking in Jackson Park was quite in keeping with the cosmopolitan character of the Fair in other respects, there having been no less than three kinds of water for the free use of visitors, and a still larger number for sale at stands or served in the various restaurants.

Tap Water.—The ordinary tap water was drawn from Lake Michigan through a tunnel extending one mile into the lake at Sixty-eighth St., which supplied also the southern part of Chicago. The analyses of this water, a summary of which is given below, have shown that it is subject to almost continual moderate and occasional excessive pollution by sewage, the extent of pollution varying with the wind and, perhaps, with other conditions. A study of these results in connection with the typhoid fever death-rate of the city has shown beyond

*Chemist, Department of Water Supply, Sewerage, and Fire Protection, World's Columbian Exposition.

question that the water from this intake is not suitable for drinking, and that it injuriously affects the health of a not inconsiderable proportion of those who drink it.

The use of this water for drinking in Jackson Park was forbidden, but unfortunately no adequate steps having been taken to enforce the orders they were but imperfectly followed and often openly violated by various parties, so that the plain tap water was at all times a commonly used beverage upon the grounds, and it was almost the only water used by the great bulk of World's Fair visitors when outside the grounds.

Sterilized Water.—This water was prepared by blowing steam into water passing continuously through a boiler-shaped receptacle, the quantity of steam being so regulated that the water flowing out had a temperature of 82 to 88° C. (122 to 137° F.). The water was then cooled by passing through a coil of pipe in cold water, and was stored in large wooden tubs from which it was drawn in tank carts to the barrels inclosed in suitable boxes at the various points where water was required.

A plant for sterilizing the water for the workmen was in use before the Fair was opened, but was unfortunately located in a place which it became necessary to clear before May 1, and sterilization was discontinued until the plant could be re-erected in another place. The boxes labeled "Sterilized Water" were almost the only sources of drinking water in parts of the grounds and during the interval when the water was not sterilized, which was extended by numerous delays until Aug. 3, over 200 of these tanks were daily filled with raw lake water, as objectionable in every way as if drawn directly from a tap, and even more dangerous to careful persons who would otherwise have avoided it, because it was masquerading under the attractive sign "Sterilized Water for Drinking Only."

On Aug. 3 the new sterilizing plant was put in operation and from that time on only sterilized water was allowed in the tanks. The water as used by the public after standing for a time in the wooden tanks was often far from sterile, frequently containing more bacteria than the tap water itself, but it was free from the specific infection present in the tap water which makes the latter objectionable, and we may confidently believe that the water in the tanks was without injurious effect upon those who used it.

Pasteur Filtered Water.—As an additional supply of water the Exposition provided a hundred drinking fountains supplied with Pasteur filtered water. These fountains, which were furnished and operated by the Pasteur-Chamberland Filter Co., consisted of capacious galvanized iron tanks, with removable covers, provided with several faucets and filled with water from filters below the tanks. These tanks were first available toward the middle of June and through June the water drawn from them contained very many bacteria, apparently due to growths in the reservoir, supported by the dirt in the tanks. Afterward, the number of bacteria was reduced and averaged much lower than in the unfiltered water, although extremely variable.

Sometimes high numbers resulted from the breaking of a bougie (filter tube), or an imperfect packing, thus allowing unfiltered water to enter the tank; and sometimes they were due to the use of the tanks as garbage cans by visitors. The water also occasionally contained a little zinc from the galvanized iron tanks. The water from these tanks was thus often of unsatisfactory quality, although a large majority of the samples have been reasonably and some entirely free from bacteria and the average quality of the water was far better than the tap water.

Waukesha Water.—This water was brought to the grounds through pipes from the springs in Wisconsin. The water was first put on sale about the middle of May and contained at that time and through June very considerable numbers of bacteria. Afterward, in July and August, the numbers were quite low, but became variable and higher during September and October. Not having had an opportunity to examine the sources of the water, I am reluctant to express an opinion upon its qualities, but it is difficult to see why a perfectly pure spring water should have had so many bacteria after its passage through 103 miles of pipe, a process which usually tends to reduce the number of organisms in the water. It should be said, however, that there was no reason to suppose that any direct infection was distributed by this water.

In its chemical composition, the Waukesha water is radically different from the lake water, and its general constancy of composition at different times and in different parts of the grounds precludes the supposition that lake water found its way into the Waukesha pipes to any considerable extent.

Waters Used in Restaurants.—At the opening of the Fair, tap water only was to be had in the restaurants, and it continued to be generally used for over a month. In June, most of the restaurants, under orders not to serve tap water to their patrons, provided filters for their water. A considerable number of these were Pasteur filters, or else filters of porous sandstone, which removed substantially all of the bacteria from the water. In two cases, mechanical sand filters were used, which, as indicated by our tests, removed only a fraction of the bateria, and were far from satisfactory. Other places used little tap filters in which filter paper, wire cloth, sand and animal charcoal served as filtering material, and these, as we found by repeated tests when they were in actual use, were without appreciable purifying effect upon the water which passed them. A few restaurants defied the order altogether and made no pretense of filtering their water. With warm weather and increased patronage, the filters of the better class which had been introduced in many of the restaurants were often inadequate to supply the demand for water and tap water was then used.

From June 15 to Sept. 1 a somewhat irregular inspection of restaurant waters was maintained by officers of the Medical Department, but was abandoned for lack of available men, and because, as the restaurants could not be compelled to supply suitable waters, the inspection was without practical effect.

Other Waters.—The soda water for sale on the grounds was uniformly prepared from tap water, and, owing to the action of carbonic acid under pressure, was, perhaps, somewhat less objectionable than the raw water.

The orange cider so freely sold on the grounds differed so widely in its chemical composition from pure orange juice that it could not have been genuine, but was probably made by dissolving substances in the tap water.

No examination of the bottled water sold in the restaurants was made, but the time of storage of such waters can usually be depended upon to make them quite safe, even in the rather improbable case of their being polluted at their sources.

Analyses.—The average composition of the tap water by months, and of the Waukesha water for the whole time, is shown in Table I.

The numbers of bacteria in the waters from the different sources were determined at frequent intervals. Table II. gives a summary of the results for tap water, Pasteur filtered and Waukesha water.

The middle numbers of bacteria found in waters from the different sources by months are shown in Table III. The numbers are so selected that equal numbers of plates were higher and lower than the figures given, as, owing to the very wide range of results, arithmetical averages would not give a fair idea of the usual results.

TABLE I.—Average Composition of Tap Water, World's Columbian Exposition.

	Temperature —degrees.— Cent.	Fahr.	Color.	Residue on evaporation. Total.	Loss on ignition.	Fixed.	Parts per —100,000.— Chlorine.	Oxygen consumed.	—Ammonia.— Albuminoid.	Free.	Nitrogen as Nitrites.	Nitrates.	Bacteria per cu. cm.
May	11.6	53	.13	16.1	3.7	12.4	.21	.08	.....	.....	.0004	.....	808
June	15.6	60	.05	15.3	3.5	11.8	.25	.09	.0109	.0012	.0001	.0070	609
July	20.2	68	.04	14.7	3.3	11.4	.27	.08	.0127	.0011	.0001	.0033	623
Aug.	22.1	72	.03	18.6	3.5	15.1	.27	.10	.0115	.0024	.0002	.0030	491
Sept.	19.8	68	.05	15.0	3.0	12.0	.31	.09	.0118	.0039	.0000	.0057	776
Oct.	14.7	59	.03	14.6	3.2	11.4	.26	.07	.0090	.0018	.0002	.0048	346
Period	....	..	.05	15.7	3.4	12.3	.26	.08	.0112	.0021	.0003	.0048	609
	Average Composition of Waukesha Water.												
Whole time		..	.01	32.6	7.4	25.2	.37	.03	.0029	.0008	.0017	.4400	460

TABLE II.—Percentage of Total Number of Tests in Which the Number of Bacteria Found were Less than the Number Stated.

	Number counts.	Sterile.	Percentage of counts giving less than: 5	10	20	50	100	200	500	1,000	2,000	5,000
Tap water May-October.....	116	0	0	2	3	6	12	25	58	81	93	100
Waukesha May-October....	71	1	1	4	21	51	66	72	86	90	92	98
Pasteur filtered July-October	58	7	26	36	48	67	78	88	93	95	100	..

TABLE III.—Middle Numbers of Bacteria in Various Waters.

	May.	June.	July.	Aug.	Sept.	Oct.	Whole time
Tap water.....	630	405	483	301	346	205	378
Waukesha	204	269	30	38	54	57	48
Pasteur filtered..	...	(345)	45	10	27	8	23
Water freshly sterilized	...	...	...	1	14	0	1
Sterilized water as used.....	...	...	...	2,100	103	38	143
Sterilized water tanks, but water not sterilized..	1,764	4,248	2,175	...	...	...	2,225

The following figures show the temperatures of the various classes of water during each month:

Temperature degrees Fahrenheit.	May.	June.	July.	Aug.	Sept.	Oct.
Tap water.....	54	61	68	72	68	59
Waukesha	54	65	68	61	56	57
Pasteur filtered..	...	(345	45	10	27	8	23
Sterilized tanks.....	56	59	67	81	74	65

The refrigerating apparatus evidently did not reduce the temperature of Waukesha as sold, during the first half of the Fair at least, and no effort was made to cool the other waters.

The summer's experience has shown the great difficulty of maintaining a satisfactory local water supply where the water in the pipes is bad.

The drinking water in Jackson Park averaged better than that of the city as a whole, and better than that of the hotels where the visitors to the Fair lodged; but if the general water supply had been good the conditions in the park would have been vastly better, and that without an effort, than they actually were, even with great care, and the use of appliances and expedients which would otherwise have been unnecessary.

FROST-PROOF MORTARS.*

Wherever a building or other masonry work has to be continued in cold weather because a press of business does not allow it to be stopped, the question naturally arises what precaution should be used to prevent inferior work being done though freezing the mortar. We have to credit the Austrian Society of Engineers and Architects for bringing this question to a practical test. The question was raised by a Vienna firm of architects, who were building in the winter a theatre in Zurich (Switzerland). The firm investigated the matter and received two opposing expert opinions. One from Professor Tetmayer, of Zurich, stated that Portland cement with salt should be used; the other expert recommended fat lime. In the winters of 1890-'91 and '92-'93 the following test was made: During a temperature below 28° F., 14 brick walls were built, each 3 ft. 4 ins. long, 6 ft. 8 ins. high and 10 ins. thick. The following mortars were used:

(1) Common fat lime mortar. (2) Roman cement mortar. (3) Portland cement mortar. (4) 1 of Portland cement to 2 of lime. (5) Cement and slag mortar.

All these mortars were tried once with cold water and once with warm water (77° F.), and some of them were tried with a 7% cold salt solution. Two walls were also built with a frostproof mortar, "Patent Hansleitner."

The first three mortars were also tested on nine rubble masonry walls, the same length and height as the brick walls, and 15 ins. thick. The water was used with the same variations as above. Half of each wall was covered with boards and the covered half showed in each case somewhat better results.

*Translated by Fr. von Emperger from "Zeitschrift des Oesterreicheschen Ingenieur- und Architekten-Vereines."

After three months the walls were examined. Wherever lime had been used, either alone or with cement, the result was a failure. The use of Roman cement gave different results, according as it was used on brick or on stone. Portland cement with cold salt solution and frostproof cement, "Patent Hansleitner," were the only mortars which gave perfect satisfaction, and these were in good order when used as exterior finish.

The report of the committee (published in full in the Journal of the Austrian Society of Engineers and Architects, Feb. 16, '94) reviews in detail other experience on this subject, quoting especially from a great number of authors of northern Europe. They all state that dry brick and stone are necessary, which is an important matter, as it is common practice to dip brick if used with cement mortar. From American practice there is a reference only to experience on the Croton Aqueduct, while the papers of W. W. Maclay (Trans. Am. Soc. C. E., VI.), P. E. Michaelis (Trans. Am. Soc. C. E., XVI.), and A. Noble, a writer on the subject, are not mentioned at all. This is the more surprising, as the experience of these three engineers indorses the results obtained, viz., that Portland cement is the only reliable building material in frost.

DIXON'S AUTOMATIC FOG SIGNAL APPARATUS.

The employment of automatic torpedo-placing machines or fog signals on railways, to act as auxiliaries to the ordinary block signals and to obviate the many difficulties attendant upon the use of torpedoes placed by hand, is receiving increased attention from the managers of railway lines of heavy traffic. Machines of this class have been used in a limited way for some years, but they seem destined to be very generally required on all railways in the neighborhood of large cities, where heavy suburban traffic is liable to be hampered by thick fogs.

The Dixon apparatus, which we illustrate herewith, and which is to be introduced in this country, is in operation in England on the London & Southwestern Ry., Great Northern Ry., Midland Ry., Barry Ry., Metropolitan District Ry. and the Manchester, Sheffield & Lincolnshire Ry., and appears to be an efficient and reliable machine. It is entirely automatic; that is to say, if one torpedo is exploded the machine puts a fresh one in its place, and whenever the signal is turned to the safety position the torpedo is withdrawn from the rail. The apparatus is the invention of Mr. J. F. Dixon, of England, and is being introduced by the Dixon Patent Fog Signal Co. The apparatus is simple and inexpensive, occupies but little space, and has proved very reliable in service. The following description is an abstract of an article in the "Engineer," of London, and we are indebted to Mr. J. P. O'Donnell, signal engineer, of London, for drawings and photographs of the plant. Fig. 1 is a general view of the apparatus, and Fig. 2 shows the regulator or dash pot:

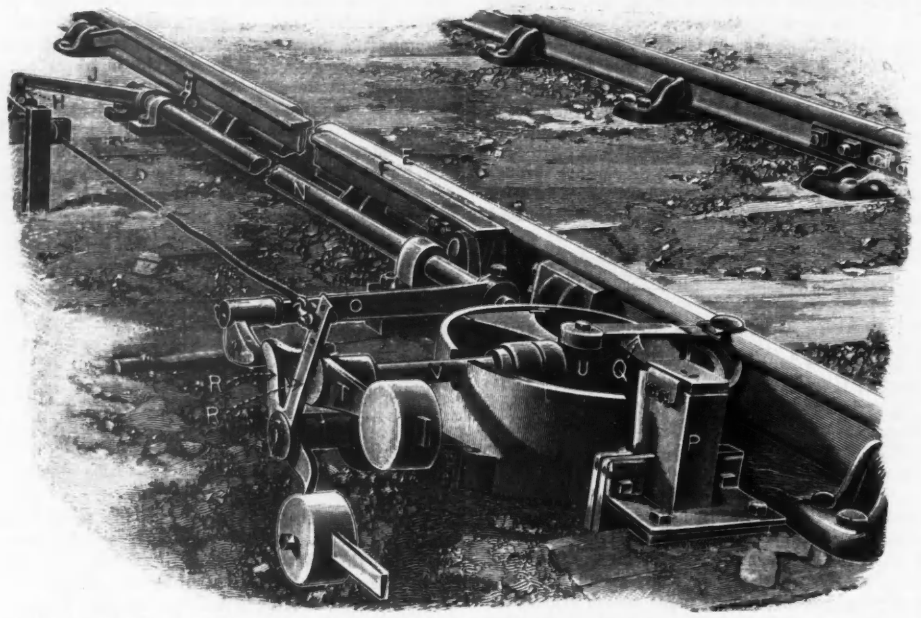


FIG. 1. PERSPECTIVE VIEW OF DIXON'S AUTOMATIC TORPEDO PLACING MACHINE.

Referring to Fig. 3, E is the rail, and close alongside of it is placed an inclined tee-bar F, pivoted at one end upon a tie. The top of this bar is at one end level with the top of the rail, while the other end is about 1½ ins. higher than the top of the rail, and is therefore depressed as a train passes over it. The depression of this bar actuates the apparatus. The arrangement really consists of two entirely separate parts: 1, the tee-bar and its controlling dashpot; 2, the detonator magazine and feeding apparatus. These two parts are not rigidly connected in any way, so that the jars to which the bar is necessarily subjected are not transmitted to the more delicate mechanism of the feeding apparatus. Fig. 3 is a section through the dashpot, and shows clearly its connection with the tee-bar. As soon as the bar F is depressed, it lifts the link H by means of the lever J, and causes the piston K to rise in the air vessel L; this piston rises freely owing to the opening of the valve M. The cover G is attached to the lifting link H, and is used merely to keep dirt out of the dashpot. At the same time the rocking shaft N is partially rotated, and the lever O (Fig. 4) is raised. The train having passed over the tee-bar, the lever O, which is counter-weighted, and the weight of the piston in the dashpot, cause the piston K to descend slowly in the cylinder L. Two vertical grooves are cut inside the cylinder L, which allow the piston to descend rapidly at the end of its stroke by permitting air to escape from underneath it. The valve M should, of course, allow no air to pass it. It is thus obvious that the speed at which a train may pass over the bar has no effect upon the action of this part of the apparatus, as it is entirely controlled by the dashpot. In fine weather the whole apparatus is put out of gear by wedging up the lever O on the dashpot side of the rocking shaft, and so permanently depressing the tee-bar to the level of the top of the rail.

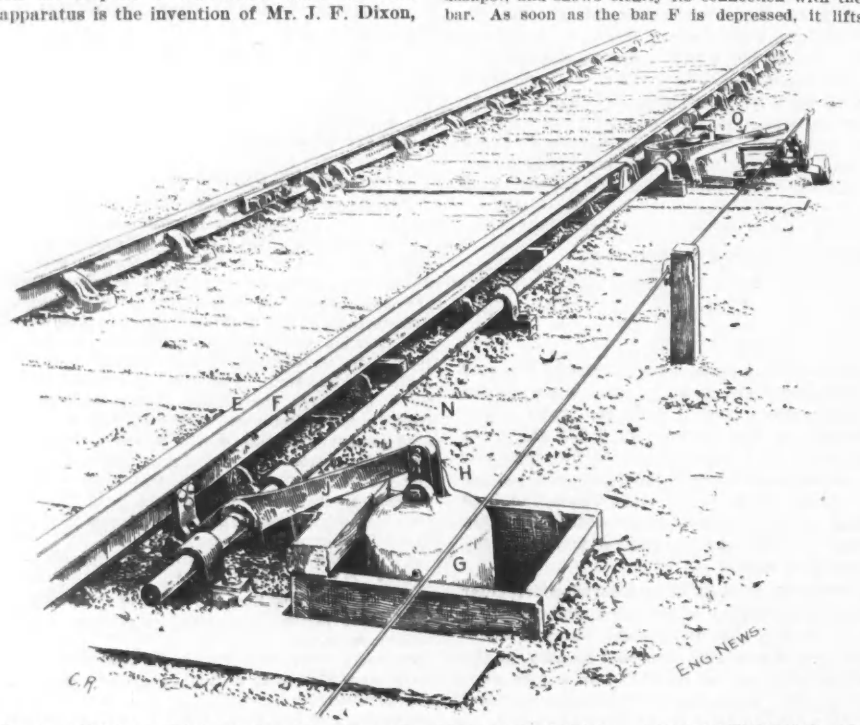


FIG. 2. TRACK LEVER, ROCK SHAFT AND ATTACHED PARTS; DIXON'S TORPEDO PLACING MACHINE.

Passing now to the magazine and feeding mechanism. Fig. 6 shows the magazine P most clearly. It consists of a cast iron box of rectangular cross-section, provided with a light spring of the jack-in-the-box type, which continually presses upward the torpedoes piled upon it; the torpedo is therefore always kept at the proper height to be seized by the forceps Q. The torpedoes are formed as shown in Fig. 5, where the torpedo proper is shown held by clips formed from a thin tinned plate. Supposing the tee-bar F to be pressed down by a passing train, or to be permanently held down as described by wedging the lever O, then the counter-weighted lever T (Fig. 7) descends and partially revolves the spindle V (Fig. 4), upon which is keyed a quadrant W gearing with a bevel wheel keyed upon the vertical shaft U (Fig. 6). Upon the shaft U is keyed the forceps Q, so that a descent of the tee-bar causes the forceps to rotate until opposite the magazine. The loose limb of the forceps is controlled by the spring A, and the method of opening and closing the jaws of the forceps is very ingenious. Suppose that a torpedo has been held upon the rail at B (Fig. 4), then a passing train would explode it, and, depressing the tee-bar, would allow the forceps to swing towards the magazine; in doing so the lower limb X, which is provided with a small roller, would pass externally along the curved blade C, and the jaws would be gradually opened until the catch D released the spent torpedo, which then would fall to the ground. The jaws of the forceps remaining wide open, would come opposite the torpedo in the magazine, and at that instant the lever would reach the end of the curved blades C, and would be smartly drawn back by the spring A, so closing the jaws of the forceps upon the torpedo. We may suppose that this series of movements has occupied two seconds; the forceps will remain opposite the magazine until the tee-bar again rises, which may take half a minute, or any shorter or longer interval desired, according to the fit of the plunger in the dashpot.

As soon as the tee-bar rises the lever O falls, and the forceps moves round and places the new torpedo on the rail. The curved blade C allows the limb X to press it out of the way, and then returns to its previous position. We have now described the action of the mechanism when torpedoes are required and it must be clearly understood that in the normal condition a torpedo is always on the rail, just as in the normal condition the signal is at danger. If the apparatus is placed out of use, the forceps remains opposite the magazine the whole time. As the signal given by the torpedo must agree with that given by the single arm, there must be a connection between the two, and this is effected

by attaching the end R of the bell-crank lever, Fig. 7, to the lever which works the semaphore signal. If now the semaphore be pulled over to the "track clear" position, the bell-crank lever descends, and its end R' catches the cam S, and causes the lever T to be partially rotated, as in Fig. 8. This action is not very obvious in Fig. 7, as the lever T is supposed to be at its highest position, and the forceps to be just taking a new torpedo out of the magazine; but in the normal position, with a torpedo on the rail, the lever T is horizontal, and the end R' comes into gear with S, owing to the fact of the center upon which the bell-crank lever turns being out of plumb with the axis of the lever T. By the descent of S, the quadrant and bevel wheels and vertical shaft U are actuated to the opposite direction to that previously described, and the torpedo is swung off the rail from position B to position B', where it remains so long as the signal is at "track clear," and is, therefore, not exploded. The semaphore can thus be worked at any time irrespective of whether a train is on the bar or not.

Another case which may be supposed is that of a train upon the bar, during which time the signalman might place the signal at danger before the train was clear. The return of the bell-crank might cause another torpedo to be placed upon the rail when it is not needed. This action has been foreseen, and a locking gear arranged. Referring to Fig. 4, a narrow bar Y may be seen, which is actuated by the signal lever. This bar Y comes over the piece Z, which is rigidly connected with the lever T, and locks the apparatus so long as a train is on the bar. As soon as the train passes over, however, this lock is freed, and the apparatus is free to work. The magazine will hold 50 torpedoes, and it can be filled very easily. A small hole is provided in the cover, and by pressing down the spring by means of a short rod, the new torpedoes can be inserted one by one. The apparatus can be made so as to place two or three torpedoes upon the rail. That at Holbeck places two torpedoes on the rail at a distance of 30 ft. apart; this needs merely a duplication of the magazine and feeding mechanism. Only one dashpot and inclined bar are needed.

In the very common use of torpedoes at distant signals, it is well known that these signals may be and are passed at danger, more especially in foggy weather. Under these circumstances it is absolutely necessary that when a train has passed such a signal at danger, a torpedo should be placed on the rails behind the train automatically. This the Dixon apparatus does. Whether the signal be lowered or not (and in a short section it may happen that a distant signal is not lowered during the continuance of a fog) one, two, or three torpedoes, as desired, are placed on the rails after the passage of each train.

ELECTRIC CORROSION OF WATER PIPES IN BROOKLYN, N. Y.

The serious effects of the return currents of electric railway circuits have been made very evident in Brooklyn, N. Y., as in other cities, by the corrosion of gas pipes, water pipes and the lead covering of telephone cables, and the Board of Commissioners of Electrical Subways in its report for the year ending Dec. 15, 1893, referred to this matter and recommended that the railway companies should be required to guarantee absolute protection from electric corrosion, or electrolysis, and that constant watchfulness should be maintained without expense to the city. In January the board submitted to the mayor a special report on this subject, accompanied by specimens of corroded iron and lead pipe, and leaden cable coverings. The commissioners are Prof. Geo. W. Plympton and Fred. R. Lee, and an abstract of their special report is given below:

The experience of Brooklyn is not notably different from that of Boston and Cambridge, Mass., Milwaukee, Wis.; Columbus, O.; Indianapolis, Ind., and Hamilton, Ont. In each of these cities similar corrosions have been detected and in none is there any doubt as to the cause. It is known to be due to the imperfections of the means provided by the trolley companies for the conveyance of the electrical current back to the generator, and the remedy for the evil will have been applied when the trolley companies shall have provided an adequate route for the electric current now discharged into the rails. It was at first reasonably supposed that the rails would afford a sufficient path, but the current declines to take that route exclusively. Upon the failure of this plan, a copper connection to carry the current past the joints was tried. In most cases this expedient failed of complete success, except where the copper bond had unusual dimensions. An account of some experiments published in the "Electrical Engineer" may be profitably quoted here.

The resistance per mile of double-track road was found to be 0.7675 ohm in dry earth without bonds connecting the rails. Where the rails were bonded with iron wire of No. 3 gage and cross-connected without a continuous return wire the resistance was 0.0737 with dry and 0.0717 ohms with wet earth. Where the track was formed with No. 3 copper wire bonds riveted to the rails, each bond soldered to a continuous copper wire of the same gage and the rails cross-connected every 200 ft., the resistance was 0.0207 ohm with wet earth. When the track was made in the same way as in the last example, but further improved by soldering the riveted bonds to the rails and spacing the cross-connections closer together, the resistance when the earth was dry amounted to 0.0254 ohm. Track bonded with two No. 4 galvanized-iron wires without a continuous return wire had a resistance of 0.0577 ohm when the earth was dry.

These figures show that some bond is necessary, and furthermore that the resistance of the rail section is so slight that the calculated resistance of the bonds accounts for nearly all of that observed. This suggests a practical point, namely, the desirability of making the bonds larger than is now the usual practice and omitting the return wire. The effect of this wire has long been generally acknowledged to be small and its value to be chiefly as a supplement to the bonds. There is a strong tendency now to do away with it entirely. It increases the conductivity of the return circuit somewhat, but probably not as much as if the metal in it were used to make larger bonds. A Johnson section 80, No. 254, girder rail for example, weighing 80 lbs. per yd., has about the same conductivity as a copper wire 1¼ ins. diameter, while a section H, 60-lb. Lewis & Fowler box rail has about the same resistance as a copper wire 1⅛ ins. diameter. No such amounts of copper have yet been used to make bonds, and until they have, the possibilities of rail returns have not been exhausted. If the copper in the return wire in the third kind of track mentioned in the last paragraph were placed in the bonds the latter would be over 1 in. in diameter, instead of 0.23 in., and the actual conductivity of the return over thirteen-fold greater. This shows that water, gas and telephone mains can be protected by better track construction, which will prove as advantageous to the railway company as to the other interests. This is one of the means of protecting mains from electrolysis, and suggests the following as a second method, which in most cases can probably be applied without much trouble.

This second method is merely the connection by metal circuits of the water mains, gas pipes and telephone cables, to which some electricity will probably always pass, with the generators at the points where there is the least resistance to return currents. These are not necessarily the points where the distance between the pipes and the generators is the shortest, for it is possible to have this shortest line through dry sand and a line nearly a few hundred feet longer through moist earth with less resistance. The electricity of the return current would be apt to leave the pipes at the moist places under such conditions, and it is possible that the return metal circuit should be located here, although somewhat longer than at another point. Old rails, heavily bonded, have been suggested for such a use, and would probably prove satisfactory.

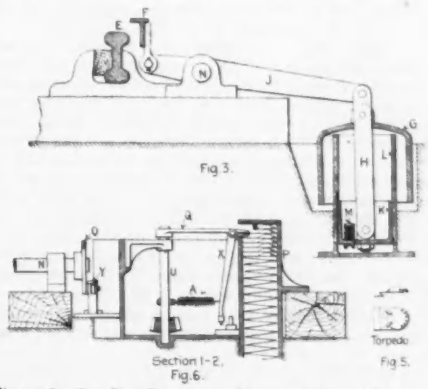
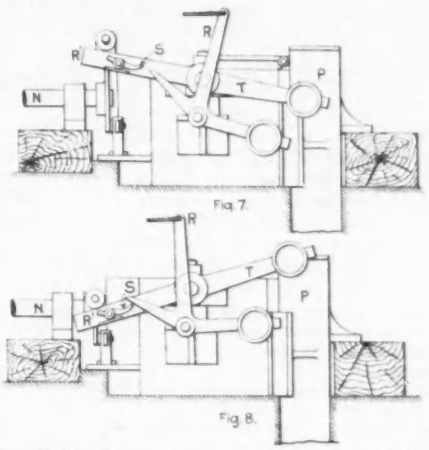


FIG. 4. PLANS OF DASH-POT AND OF TORPEDO HANDLING APPARATUS; DIXON'S TORPEDO-PLACING MACHINE.

Figs. 3, 5, 6. Sections Through Dash-Pot and Torpedo Reservoir, and View of Torpedo; Dixon's Torpedo-Placing Machine.



Figs. 7, 8. Connections from Semaphore to Torpedo Machine.

It should be said in regard to this second method, that in making connections with the underground systems of pipes and cables, that the points of such connections would require frequent examination. A copper connection with an iron pipe underground would not long remain a reliable conductor, unless special care and watchfulness were given to it. A better way to insure the conduction of the current is doubtless to make the rail continuous by welding. This method will be employed on the new trolley line soon to be built in the southern part of the city. The most complete solution of the problem is afforded by the double trolley, by which the return current is provided for by an overhead wire similar to the one for the outgoing current. But it is to be hoped that it will not be necessary to resort to this method. Some notes of experiments obtained through the kindness of Mr. I. H. Farnham, electrician of the New England Telephone Co., and relating to the early experience in Boston, are here given.

When the action of the current was first noticed, the experiment of grounding the cables to lead plates buried in manholes was tried on quite an extensive scale, but was soon abandoned as being impracticable. The quantity of electricity to be dealt with was so enormous that the buried plates offered no appreciable protection to the cables. If such a system were feasible, the expense for the constant renewal of plates would be very large.

The severity of the action may be diminished, to a certain limited extent, by so arranging the direction of the current used for the street railways as to make it pass out over the trolley wires and back through the ground. In this way the direction of the current would be quite generally from the earth to the cables, thus diminishing in certain places the corrosive action. This method would not be a complete protection from the corrosive action, as there would be places where the current would still flow from the cables. Even though the current is uniformly to the earth from the cables, there is the possibility of an action caused by alkaline substances formed about the cable, due to the decomposition by the current from

the street cars of the soluble salts contained in the surrounding earth. These alkaline substances are capable, under certain conditions, of dissolving the lead, when the currents are shut off or much reduced, as would be the case at night.

As there has been some misunderstanding in regard to the potential measurements made in connection with the numerous corrosion investigations, it should, perhaps, be impressed upon those who are about to carry on similar investigations, that the potential measurements between the cables or pipes, and the material surrounding them should, in the majority of cases, only be looked upon as indicating the direction in which the current tends to flow.

To say that the pipes and cables are even practically safe from corrosion when the measurements are below a specified figure would be extremely misleading. These measurements are, in a certain sense, like the measurements which might be made in an electrolytic cell, between one of the electrodes and various portions of the electrolyte, so that it is possible to conceive of almost zero potentials in the immediate vicinity of the most violent electrolytic corrosive actions. The fact should be closely borne in mind that whenever we have a current passing from an easily oxidizable metal to the liquid, such as would be encountered in the earth, corrosion is bound to occur. A large number of electrolytic experiments have been carried out showing the extremely low potentials (measurements between the electrodes) at which corrosion is found to take place. In may cases iron and lead were destroyed under the conditions encountered in the underground systems at potentials considerably under 0.5 volt.

The conclusions fairly drawn from these notes and from our own experience is that considerable injury is being done to underground pipes and cables, and that it will continue along the lines of the trolley roads (except where the elevated railway extends above them) until better methods of returning the current to the generator are put in practice. The electricians of the several trolley roads are fully aware of the situation and have speedily applied means of prevention in localities where the corrosion had been detected. But it is doubtful if the method of final cure of the difficulty has yet passed the experimental stage.

CARRIAGEWAY PAVEMENTS FOR LARGE CITIES.

At a late meeting of the English Society of Arts, Mr. Lewis H. Isaacs, Assoc. Inst. C. E. and Suveyor to the Board of Works for the Holborn District of London, read a paper with the above title, which may be taken as an excellent resume of English practice and experience in paving the streets of large cities. The paper is given practically in full, as follows:

The points to be aimed at in the formation of a good carriageway pavement may be set out as follows:

1. It must be a sanitary pavement, and as noiseless as possible.
2. It must be safe for horses, affording sufficient foothold with the minimum of traction.
3. It must be as free from dust and mud as possible.
4. It must be economical, not only as regards its first cost, but also with respect to its maintenance and cleansing.
5. It must be durable.
6. It must be easily cleansed and non-absorbent of moisture.
7. It must admit of being readily taken up and quickly relaid for repairs at all seasons.

The author then discusses the modern requirement that the pavement shall wear well when street rails are laid through it, and states that this requirement is one which has been thus far only partially met.

The pavements which are usually met with in the streets of our large cities and towns divide themselves into two classes, namely, those which are laid in parallel courses at right angles to the curb, and those which are without joints—longitudinal or transverse. The first class embraces gritstone, granite setts and wood blocks, while asphalt, macadam and ballast or flint roads constitute the second.

Let me, at the outset of my remarks, lay down a general proposition, the importance of which cannot be too much impressed on the mind of the municipal engineer, that whatever the pavement he may have to form, its foundation is of primary consequence, and should receive the same attention as in other engineering work. A carriageway pavement without a solid foundation is nearly as frail as a house built on sand. A London engineer, of much experience in this class of work, has said that "the foundation is the pavement." The surface material is merely a covering, which of necessity must wear out, and yet the foundation will constitute a pavement. It cannot safely be expected that the pavement will more than temporarily be better than its bed.

The very best foundation for paving purposes is one composed of Portland cement and clean sharp river ballast, when the last-named material can be obtained, in the proportion of six of ballast to one of cement.

Next in importance to the foundation is the contour or cross-section of the carriageway. The longitudinal gradient of the road or street in a great degree controls this, it being necessary to give a more convex contour to a level or flat street than to one having a good fall. The material used for the paving has also to be taken into consideration, gritstone requiring more camber than granite, and wood than asphalt. No fixed rule can be given for the cross-section of a carriageway pavement, but it may be assumed that about 1 in 30 to about 1 in 40 would be sufficient, according to the gradient of the road and the material employed.

Gritstone Setts.—Carriageway pavements composed of gritstone setts are not to be met with in London, and I question if many of the London municipal engineers have even heard of them. In the north country, and especially in Lancashire and Yorkshire, in which there are suitable quarries, they are used to a large extent. The material has many advantages for the paving of carriageways where the traffic is moderate, or where the gradient renders the employment of granite dangerous, while wood or asphalt could not even be thought of. It is not, however, sufficiently durable where the traffic is heavy, and this is its great defect, as it involves frequent repairing and renewal, with corresponding expenditure. The stone should be obtained from a good gritstone quarry, and should consist of a hard, light brown or yellowish-brown grit, and not too close a fiber.

The setts must be cut so that the grain of the stone runs parallel to the length of the sett, and consequently at right angles to its width. This is of the utmost importance, as setts with the grain wrongly cut will soon show the effects of wear and fall into holes. The reason for this is obvious, for where the grain is parallel to the width of the stone it is in the line of the traffic to which it offers the least resistance. Pavements of this material are not slippery, do not present too much traction, afford excellent foothold for horses, and are speedily laid and repaired. They are not so noisy as granite, and are considerably less expensive, especially when the quarries from which the gritstone is obtained are in the immediate neighborhood of the work; but for durability and general usefulness they cannot be compared with granite. When the cost of the maintenance, repair and cleansing has been added to the first cost the supposed cheapness disappears.

Gritstone setts vary in depth from 8 ins. to 10 ins., the latter being the most useful, and, though costing more in the first instance, are more economical in the end, inasmuch as when the 10-in. setts are worn down, even as much as 2 ins., they can be taken up, redressed and relaid, which the 8-in. sett will not admit of.

The width of these setts varies from 5 ins. to 7 ins., and the length from 7 ins. to 10 ins. Although it is to be preferred that gritstone setts should be of one width, it is not absolutely necessary that they should be so, as in the case of granite setts, inasmuch as a horse can obtain foothold on the stone itself, while on granite paving the foot of the horse, if placed on the center of a sett, generally slips back until it reaches the joint. With this pavement, as with granite, the narrower the courses on a sharp gradient the better. The face of the setts may be left somewhat rough, as this will soon be rectified by the traffic. It is not usual to provide artificial foundations for gritstone pavements, unless the ground be found to be soft or unreliable, in which case blue lias lime concrete is used. In the north country, where furnace ashes are, as a rule, easily procurable, they are spread on the surface of the foundation to the depth of about 1 in., on which the setts are laid.

The grouting used in the north country for this class of pavement, as also for granite setts, differs materially from that which is in vogue in London. The joints, which are usually ¼ in. wide, are swept over with gravel or slag until they are about half full, after which they are flushed up with boiling pitch and tar.

I cannot advocate the use of these materials—pitch and tar—for top grouting, inasmuch as, even with the employment of the best component parts, and the greatest care in their admixture, they are apt to give under the influence of the sun, with disastrous results to the pavement and to those pedestrians who may have occasion to walk over it.

This method of grouting, it is only fair to mention, has one feature in its favor, namely, that it prevents water from percolating into the foundation and thereby destroying it. Before quitting this portion of our subject I ought to say that the somewhat soft nature of gritstone does not qualify it as a suitable material for paving works in conjunction with tramway rails.

Granite Setts.—For durability and economy there is no form of carriageway pavement now in use that can equal, much less surpass, that made of granite cubes of setts. Great care, however, should be exercised in the selection of granite, avoiding the use of one which will wear smooth and acquire a polished surface, for this is practically the only objection to the exceedingly hard granites from the quarries of North Wales and Guernsey, except the noise caused by the passing traffic, which is the great drawback to all granite pavements.

Being non-absorbent they make but little dust or dirt, and are therefore comparatively cleanly. In certain conditions of the atmosphere, in common with most other pavements they are slippery, and they do not afford the ease of traction which follows the employment of wood or asphalt. It may safely be asserted that the noise which the employment of this pavement produces is the main reason why, in these days, granite is no longer regarded as a fit and proper material for the carriageways of the leading or more important thoroughfares in our large cities. I need not further dilate upon this branch of the subject, for he would be a bold municipal engineer who would venture to propose for paving the principal streets of a town, over which there passed any considerable amount of traffic, any other than the so-called noiseless materials.

Whatever the class of granite that may be determined upon, it is absolutely essential that it be well squared and dressed before it is laid.

The sizes of the setts in most general use are 9 ins. × 4 ins., or 9 ins. × 3 ins.; 7 ins × 4 ins., or 7 ins. × 3 ins.; 6 ins. × 4 ins., or 6 ins × 3 ins., and 5 ins × 3 ins. The setts, which are only 6 ins. or 5 ins. deep, should not be used in leading thoroughfares where the traffic is very heavy; they may, however, be laid in streets of lighter traffic, and while in the case of the deeper setts the concrete foundation should not be of less depth than 9 ins., this may be reduced to 6 ins. where the shallower blocks are employed.

Let it also be remembered that a block 3 ins. wide is always preferred to a 4-in., as affording a surer foothold for horses, and, in streets having steep gradients, the 4-in. block ought never to be used.

Care should be exercised to insure that the setts are dressed truly square, the sides and ends of each stone being perpendicular to its top and bottom, so that the areas of the two latter are equal. This is absolutely necessary in order to insure stability and firmness to the pavement, and also to admit of the setts being reversed when, after the traffic has passed along the surface for some years, a relay of the roadway may become necessary. It will be perceived that if the sides of each stone are not truly square to its face, then the bottom is less in area than the top, and a condition of unstable equilibrium is set up in the first instance, while the setts cannot be reversed as just suggested. In granite, as in gritstone setts, it is not necessary, as regards the tops of the stones, to have exact uniformity of surface, as a certain amount of roughness is desirable in order to obviate slipperiness.

The contour of a carriageway has been previously referred to, and the necessity for speedily carrying off surface water will at once be recognized. That brings us to the consideration of the channels and the gullies in connection therewith. Ordinarily the channels are formed of two or more courses of cubes placed parallel to the curbs and at right angles to the other cubes; but in flat streets better channels are made by using blocks of granite 12 ins. or 15 ins. wide, and of the same depth as that of the cubes. This plan allows the rain or other surface water to flow more quickly to the gullies, there being less friction owing to the less number of joints, and a more even surface. In the case of streets having very steep gradients a second row of granite blocks similar to those just described, should be laid on the left or "near" side going up hill, and at a distance, center to center, equal to the average gage of the wheels of the traffic most frequently using the street. This class of pavement is of great service to heavy traffic on a steep gradient, affording the minimum of traction to the wheels of vehicles, while the granite blocks between give good foothold for horses.

The granite setts having been duly laid, the next operation in connection therewith is the grouting. I have already expressed my disapproval of the mode of grouting with pitch and tar which prevails in the north country. Let me describe the grouting I would use in place of this, and briefly, I would say, where the concrete foundation is composed of lime and gravel, then the grout should be lime and sand, but where the concrete is mixed with Portland cement the grout should also be of cement and sand. This insures the proper amalgamation with the foundation of that portion of the grout which passes through the joints of the setts and falls on top of the concrete. In speaking of these joints I should observe that they ought to be as thin as possible, the cubes being laid touching stone and stone both on the sides and ends. I have referred to the superiority of the 3-in. over the 4-in. granite cube. Let me, in support of this view, quote what Colonel Haywood, the engineer to the city sewers, who may be termed the doyen of municipal engineers, says on the subject:

The 3-in. granite pavings are the safest, as giving the best foothold for horses; on such a pavement horses were less strained, there was less wear and tear of vehicles, and a greater degree of quietness and comfort;

they made the most even pavement and retained an even surface longer than any other stone pavement that had been tried, and consequently were the best for large towns with great traffic.

As to the cost and duration of 3-in. × 9-in. setts of Aberdeen granite laid in Gracechurch street, with a traffic of from 5,000 to 6,000 vehicles per day, he says the cost in the first place was $3.50 per sq. yd., laid complete. During the time it was down it required three relays, the first five years were free of cost for repairs and the outcome at the end of 25 years was, after giving credit for the old material, as follows:

	Per sq. yd. for 25 yrs.	Per sq. yd per year.
First cost, including foundation	$3.50	14 cts.
Repairs, three relays at 24 cts. each	.72	4 "
" 20 years at 1¼ cts. per year.	.30	
Total expenditure	$4.52	18 cts.
Credit old material	.51	2 "
Net total cost	4.01	16 cts.

These figures are useful as demonstrating that the best material of its kind is, after all, the cheapest. In the year 1857 I received instructions to pave the carriageway of High Holborn. I recommended the use of 3-in. × 9-in. Aberdeen granite blocks, but this was overruled on the score of what subsequently proved false economy, and 4-in. blocks were laid. The paving cost $3.56 per yard, laid complete. It was kept in repair for three years by the contractors, without cost. It was twice relaid during the time it was down, 20 years beyond the three, or, in all, 23 years, at a cost of 66 cts. per yd. The figures work out as follows:

	Per sqyd. for 23yrs
First cost, including foundation	$3.56
Repairs, two relays at 33 cts	.66
Repairs, 20 years at 2 cts. per year.	.40
Total expenditure	$4.62
Credit old material	.52
Net total cost	$4 10

or 18 cts. per sq. yd. per annum (in round figures) for a period of 23 years, at the end of which time the cubes were dressed down averaging 5 to 6 ins. in depth, and now constitute the paving of several minor streets in the Holborn district. It is, therefore, within my power to state, from personal experience, that granite cubes will last 36 years with a total vertical wear of 4 ins. and still form a suitable pavement for the second or third-class streets of larger cities.

It may also be stated in favor of granite that it forms the most suitable paving material in juxtaposition with tramway rails.

By a letter received from that eminent firm of pavers, Messrs. John Mowlem & Co., I find the prices of granite paving have advanced considerably since these pavements (Gracechurch street and Holborn) were laid down. Thus the 3-in. × 9-in. laid in the first-named street would now cost $4.32, as against $3.50.

In answer to my inquiry as to the average life of granite paving, Messrs. Mowlem & Co. remark: "We really hardly know what to say beyond giving two facts, of which we are quite sure, viz. (1): 4-in. × 9-in Aberdeen granite pitching was laid by us in the Commercial road, Limehouse, in the year 1873, and the bulk of it is there still, and it has only been relaid once with a percentage of new. (2) The roads round the Central Markets at Smithfield were paved by us with 3-in. × 9-in. Aberdeen granite about 20 years ago. This has, as you know, just been relaid, none of the stones being less than 6 ins. deep and many of them hardly worn at all. We do not think we should be wrong in saying these roads will last for another 10 years, if not more."

On the subject of the charge involved for repairs of granite pavements they state that "the cost of repairs would not average more than say 6 cts. per yd. per annum. This would allow not only for the one relay with a certain percentage of new, but also for other patching repairs."

Wood Pavement.—It must have fallen under the notice of all observant people how much the employment of wood as a paving material has increased of late, but until the receipt of a letter from Mr. Michie, the courteous secretary of the Improved Wood Pavement Co., in answer to one I addressed to him asking for information on the subject of wood pavements generally, I had no idea that the increase was so large. On this branch of the subject Mr. Michie observes:

During the last four years the increase in the area of wood paving is very remarkable. From 1872 to 1889, inclusive, this company laid 1,030,000 sq. yds., equal to an average of 58,000 sq. yds. per annum. From 1890 to 1893 inclusive, 520,000 sq. yds., equal to an average of 130,000 sq. yds. per annum. This year we are paving for the Strand district, 22,000 sq. yds.; for the Hackney district, 20,000 sq. yds.; for the St. George's district, 26,000 sq. yds.; various districts, 20,000 sq. yds., all at present macadam or stone pitching, and in one case asphalt. In Kensington and the city we are doing about 40,000 sq. yds., but in this case there is no increase of area, as the roads were already wood paved. We are extending our operations to the outlying districts, such as Chiswick, Kilburn and Hampstead. Several of the vestries are doing their own wood paving. I am therefore not in a position to state correctly the extent of their work, but, on the whole, they are increasing the area of wood paving enormously.

From the same excellent authority I learn that the current price of wood pavement, laid according to the system of the Wood Improved Pavement Co., is as follows: 6 ins. of Portland cement concrete, floated to a fine surface, 5-in. block of yellow deal, pickled in creosote oil; ¼-in. joints run in with asphalt (about 1 in.) and cement grout, top dressing, etc., about $1.92 per sq. yd. If creosoted under pressure, $2.04 per sq. yd. In regard to maintenance the company is prepared to keep in repair the carriageways laid under their system one, two or three years free of cost, according to agreement, and for a further 15 years at from 14 cts. to 24 cts. per sq. yd. per annum, according to the traffic. As to the life of the Improved Wood Co.'s pavement, Mr. Michie estimates it as from 7 to 10 years, the average being as nearly as possible nine years. Assuming, therefore, that for a first-class thoroughfare the wood pavement cost, in the first instance, $2.04 per yd., that for two years it was maintained free of cost, and for a further 15 years it was maintained at 24 cts. per yd. per annum, or a total of 23s. 6d.; this, divided by 17, would represent the net annual cost per sq. yd. to be a fraction over 33 cts.

This compares with 20 cts., average annual cost of the granite paving in Gracechurch street over a period of 25 years. It should also be borne in mind that, in the case of the granite pavements, the material when taken up after these long periods of service still admitted of further use in minor streets. When we come to consider the cost of asphalt pavements, the same economy as to granite for a paving material will, no doubt, receive further demonstration.

It is unnecessary to mention again the concrete foundation for wood paving, as my previous remarks in regard to concrete for granite setts equally apply to wood blocks. Taken all round, the best wood to use for this purpose is Baltic red timber or yellow deal, which must be thoroughly sound and well seasoned, absolutely free from sap, shakes, knots or other imperfections.

Within the last few years there has been a strenuous endeavor to introduce denser and harder woods for paving purposes, notably Jarrah and Karri wood, but objection is taken to these woods that they are hard and slippery and also noisy. I have before me an account of the meeting of the Kensington Vestry on Nov. 8 last, in which a report was submitted from the Works Committee stating that complaints had been received relative to the noise caused by the trial sections of Jarrah and Karri wood recently laid in the Brompton road. The Works Committee recommended that the sections of hard wood in question be removed, and crosoted deal blocks substituted therefor, and, after some discussion the recommendation was agreed to. The expense of these woods, also, is almost prohibitive, the comparison being $51.13 for yellow deal, as against $114.45 for Jarrah, so that Jarrah would require to last 17 to 18 years to be equal in price to yellow deal creosoted.

The setting the wood blocks should not commence, as in the case of granite pavement, close to the curb, but about 7 or 8 ins. away from it, this space being the last to be filled up, so as to allow for any swelling of the wood, and thus counteract the pressure against the curb, and lessen the likelihood of their being forced out of place. In the early days of wood paving, and, indeed, until a comparatively recent date, joints of about ¼-in. to ⅜-in. wide were made between the parallel courses of the wood blocks, and these were obtained either by using laths of the required width, placed between each row and afterward removed for the grouting, or by means of three iron studs having square heads and driven home into the side of the block, so as to form an equilateral triangle, the latter being the preferable mode. Of late the joints between the courses have been done away with and the blocks are laid close together, as in paving with granite cubes, the sides and ends touching. It has been found that this close-jointed pavement results in a longer life, the reason not being difficult to find, the abrasion and rounding of the wood blocks being more pronounced when laid with a joint between each course than when laid with the sides touching. The grouting may consist of Portland cement and sand only, or of pitch and tar or asphalt for two-thirds of the depth of the block, with Portland cement grouting on top of that. The Improved Wood Pavement Co. simply brush or squeegee hot tar, tempered with a little pitch, over the surface, until it disappears between the blocks, and then spread a little sand over all. The channels should be formed by means of two rows of blocks, laid parallel with, and not transversely to, the direction of the street, 4 ins. below the curb and flush with the other blocks.

Wood blocks are not a suitable material for paving next tramway rails, as they are unequal to the wear and tear of the tram itself, to say nothing of the goring which takes place on the edges of the tram rails, by reason of the ordinary vehicular traffic. I could cite many instances as to this, but a case, which no doubt has come under the observation of many here, is that part of the Gray's Inn road lying in the parish of St. Pancras, paved with wood some three or four years ago, and which has been in the hands of the road authority ever since, owing to the deep and dangerous ruts formed next the edges of the tram rails by the traffic of the tram itself, as well as that of the ordinary wheeled traffic. Many palliatives for this have been tried, such as the insertion of Jarrah or Karri blocks next the rails, but the resulting improvement is not very great, while the inconvenience to the public it at times almost intolerable.

With regard to gradients, no road having a greater fall than 1 in 30, or at most 1 in 27, should be paved with wood, and constant and watchful care should be exercised during certain conditions of the atmosphere, when it may be necessary to use grit to prevent slipperiness.

The advantages of wood pavement are:

1. It is, as yet, absolutely the least noisy of all pavements.

2. It gives the minimum of traction with the exception of asphalt.

3. It is comparatively clean, as, if properly formed, it should make little or no dirt.

4. In the event of a horse falling on it he can rise more easily than on a granite or asphalt pavement.

But wood pavement has one most serious disadvantage. It offends more than any other against public hygiene. If time would permit, I could quote the opinions given by authorities both at home and abroad in proof of this assertion. But I will content myself by asking you to rely on the evidence afforded by your own sense of smell as to this. Let any one dwell, say for 24 hours, by the seaside or in the pure air of a rural district, and travel to town, alighting, for example, at the Victoria station, the roadways of which, as you know, are paved with wood. What greets him on arrival The most sickening odor given off by the pavement in question. You will say this is mainly or entirely owing to the circumstance that the wood pavement is under a glass roof on which the rays of the sun at times fall fiercely. But step across the station yard and traverse Victoria St. The same sickening odor—if not quite so overpowering as in the station itself—follows you. And this leads me to say, avoid using wood pavements in narrow streets, or even in comparatively wide streets where the height of the buildings which abut on the same prevents the free passage of air. I shall have to deal further with this portion of the subject, when I come to speak of street cleaning.

Asphalt Pavement.—Under this head the author describes the European asphalts composed of a bituminous limestone impregnated with bitumen. We omit his description of this pavement, its method of laying, etc., as it is matter with which engineers are familiar, only remarking that he limits its use to grades not steeper than 1 in 60. Concerning the cost and durability of asphalt pavements the author says:

On the score of durability, asphalt takes a high stand, in proof of which it has been stated that after it had been laid down in Cheapside eight years, with a traffic of more than 500,000 tons per annum per yard of width, it had only been reduced in bulk five-eighteenths and two-sevenths in weight, and if this wear was proportional throughout, it was calculated the life of the pavement in question would not be less than 22 years. Much would depend, however, upon the part of the roadway from which the trial piece was taken, whether from the crown of the road or near the curbs, and, again, whether new asphalt had been laid for the repair of that particular spot.

As to the cost of asphalt, I addressed letters of inquiry to Mr. Bassett, the manager of the Val de Travers Asphalt Paving Company, and to Mr. Vian, the Secretary of the French Asphalt Company, and the answers received from those gentlemen practically amounted to this: that for an asphalt pavement, suitable for a leading London thoroughfare, 2¼ ins. thick, on a bed of Portland cement, concrete 6 ins. thick, the price is $3.50 per sq. yd, the contractor keeping it in repair two years free of cost. The subsequent charge for maintenance varied according to the nature and quantity of the traffic passed over the carriageway; thus, while Coleman St. cost only 6 cts. per yd. per annum, Cornhill cost 36 cts. and Cheapside 42 cts. Taking the two extremes, the mean is 24 cts. per yd., which is the price paid for maintaining the asphalt carriageway of High Holborn, for a period of 15 years, after being kept at the contractor's cost two years. It would, therefore, follow that the first cost at $3.50, and maintenance for 15 years at 1s., would amount to $7.15, and this, divided by 17, would give, in round figures, 42 cts. as the cost per yard superficial per annum during the life of the pavement. This figure of 42 cts., therefore, compares with our two examples of granite paving 20 cts. in Gracechurch St.; as, also, with 3 cts. for wood paving.

The asphalt companies say it is often found that, after 17 years, the material is still in good condition, in which case they continue to maintain it at a slightly higher cost per yard. Thus, the French Asphalt Company paved King St., Cheapside, in 1874, the contract for the maintenance of which expired in 1891, and was then renewed up to 1896.

In the city of Berlin, the asphalt contractor has to maintain his pavement gratis for four years, and then receives an agreed sum per square yard per annum

for 15 years. Mr. Vian, in his letter to me, writes as follows:

It is usually found that, in main thoroughfares in the city of London, the 17 years allotted is a fair life, and that after that time the pavement is better for being relaid. On the other hand asphalt has not been long enough in use as a paving material for any statement to be made as to the possible length of its life under more favorable conditions. Pavements are in existence which were laid 20 years ago, and have, so far, not yet required repairing, and which may, for anything that is known to the contrary, easily endure for another 20 or even 40 years. Such results are attained in side and back streets where there is sufficient traffic to keep asphalt firm, but not enough to wear it away to any appreciable extent. It would, therefore, be an underestimate of the truth to say that the average life of an asphalt pavement is 20 years.

I give you this extract from Mr. Vian's letter, but it must not be understood that I indorse all he advances, for I am a little skeptical about 40 years' life of an asphalt pavement anywhere, even under the most favorable circumstances. I give you another extract from Mr. Vian's letter which is also very interesting. On the question so often raised of the slipperiness of asphalt he says:

Recent statistics taken in Berlin show that accidents to horses caused by their slipping on asphalt become fewer and fewer, although the area of the asphalt paved surface is continually being increased. The reason is partly that the horses become accustomed to asphalt, and partly that, as asphalt paved streets become more numerous, less mud is brought on to the asphalt from streets otherwise paved, and it is dirt of this sort which is the chief cause of slipperiness. Unless a great revulsion in public feeling takes place in Berlin, it may be safely anticipated that before many years have passed the whole city will be paved with asphalt; 80,000 to 100,000 sq. yds. are systematically so paved each year, and active competition prevails among the inhabitants of streets not yet thus favored as to which has the better claim to have an asphalt pavement first.

These observations on the very extended use of asphalt as a paving material in Berlin are quite confirmed by the following letter from Mr. Louth, the agent of the Neuchatel Asphalt Co. in that city:

Berlin is a city of 1,600,000 inhabitants, not reckoning the suburbs, and has a total street area (carriageways) of 4,900,000 sq. m. Of this, 1,020,000 sq. m. are paved with compressed asphalt, of which we have laid 415,000. Wood paving has been laid to the extent of 82,000 sq. m. Asphalt has been extensively laid of late; this year about 80,000 sq. m.

The main streets paved with asphalt are thoroughly washed and cleaned every morning by gangs of cleaners. During the day the men and boys work singly, but should a good shower of rain fall, they immediately assemble, and make use of the opportunity to wash and clean the streets again. Owing to the general dryness of the climate, the asphalt is less slippery here than in London. Fogs are quite unknown. Snow, of course, is very troublesome on the asphalt. Asphalt is certainly the favorite paving; and 100 petitions to the town council from the inhabitants of 100 streets, asking for asphalt, is nothing unusual in the course of a year.

Accompanying Mr. Bassett's letter is a sample of the original asphalt paving of Threadneedle St., laid in May, 1869; and cut up when the street was relaid in August last, a period of over 24 years. Threadneedle St. is not a street of large traffic, but this sample may be accepted as the best possible evidence that the life of asphalt pavements in back or side streets is not limited to 15 or 20 years.

On the score of hygiene, asphalt holds pre-eminently the first place, owing to its impermeability and the consequent impossibility of absorption on its part, and in addition to this it may be stated in its favor that it is more easily cleaned and dries more readily than any other pavement. It is free from jolting, is comparatively noiseless, and is readily repaired in a very short time.

Macadamized Roads.—The foundation for macadamized roads in and about London is formed of "Hardcore," that being the term applied to a mixture of the debris of builders' and dust contractors' yards, clinkers from gas and other furnaces, broken pottery, and other hard material. In the north of England and towns situate near blast furnaces the foundation is of slag. The thickness of the foundation depends upon the nature of the subsoil, the amount of traffic to pass over it, and the materials with which it is to be formed, but it should not be less than 12 ins. in thickness. This should then be rolled until 8 ins. or 9 ins. thick; on this a layer of Thames ballast 5 ins. thick should be laid, and the whole well rammed down. The macadam, or broken granite, is then laid on the ballast in three successive layers, 3 ins. thick, rolled separately, until the three combined form a substance of 6 ins.; upon this a thin layer of sharp sand should be scattered, well watered and rolled.

Broken Guernsey granite, the size of which should not be more than 2½ ins., forms the best metaling. The roller employed should not weigh more than five tons, for when rollers of heavier weight are employed they are apt to crush the gas and water services, and even to cause injury to the mains themselves.

An ordinary macadamized road constructed in this manner costs about $1.44 per sq. yd. in London, and when the traffic is heavy, repairs become very costly, for upon the road is put material costing $3.12 per cu. yd. to be pulverized and carted away either in the shape of mud or dust at an additional cost of $.96, or a total of $4.08 for material only. It is on record that when Piccadilly was a macadam road, the annual cost of maintaining it was 96 cts. per sq. yd. per annum. This fact tends to prove that the limits within which macadam roads are suitable for heavy traffic are soon reached.

Street Cleaning.—Cleanliness of surface has an important bearing upon the slipperiness of all carriageway pavements; some, however, are affected to a greater degree thereby than others. Wood and asphalt must be kept clean for safety. These pavements are most slippery when they are in what I term the transition state, that is to say, when slightly wet or imperfectly dry. When very wet or very dry, they are as safe as, if not safer than, any of the others. Colonel Haywood has shown that when the pavement is damp a horse can travel 125 miles before it falls; when the pavement is wet, 193 miles before it falls; when the pavement is dry 223 miles before it falls.

The art of cleaning the surfaces of our roads is but imperfectly understood in this country. The fault does not entirely lie with our municipal engineers; nevertheless, we must cross the English Channel in order to see what systematized and efficient street cleaning can do in order to make street surfaces not only innocuous, but agreeable to both sight and smell. Paris, Berlin, Vienna, even Buda-Pesth, although the last-named is almost on the confines of civilization, can give us most useful lessons in this particular.

I have always maintained that the only rational manner of dealing with the paved surfaces of a town is to treat them as you do the paved surfaces of your houses when you desire to cleanse, namely, to wash them. You could render the hygienic effect of this treatment more pronounced if such simple disinfectants as certain of the residuals of gas manufacture were added to the water when atmospheric conditions rendered that course necessary.

I am informed that a gallon of soluble creosote, or a gallon of liquid carbolic acid, added to 2,000 gallons of water, would prove in each case an invaluable disinfectant at but trifling cost. As regards wood pavements and the offensive miasmatic odors now given off therefrom, previously referred to in this paper, the effect of the suggested washing and antiseptic treatment would go a long way to remove the distrust in which this form of pavement is now held, and speedily restore it to public favor.

Comparative Merits.—At the commencement of this paper I stated what were the salient points to be aimed at in the formation of a good carriageway pavement. Let us see how the different materials we have been considering come out of the inquiry. I discard from this award of relative merit and demerit all other materials, save granite, wood and asphalt, grit-stone being only locally employed, while macadam and ballast should only be used in the suburbs of large cities and towns.

For convenience of reference I have tabulated these results and they come out as follows:

Table of Comparative Merits and Demerits.

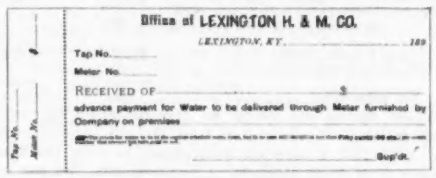
	First.	Second.	Third.
Public hygiene	Asphalt	Granite	Wood
Noiselessness	Wood	Asphalt	Granite
*Safety for horses	Wood	Asphalt	Granite
Cleaning	Asphalt	Granite	Wood
Durability	Granite	Asphalt	Wood
Economy	Granite	Wood	Asphalt
Facility of repairs	Asphalt	Wood	Granite
Facility for tramways	Granite	Wood	Asphalt

* This is under existing conditions as to cleaning.

THE WATER METER SYSTEM OF LEXINGTON, KY.

By S. A. Charles, Superintendent.

Prior to the enlargement of its reservoir, just completed, the Lexington (Ky.) Hydraulic & Mfg. Co. was forced to the greatest economy in the use of water and the use of meters to prevent waste was an absolute necessity. Our experience has been so satisfactory that perhaps an account of it may be of interest and profit to others. Motives of economy compelled us to adopt every labor-saving device we could think of to avoid unnecessary help in setting and reading meters, keeping them in running order and in reducing the clerical work of book-keeping and collection to a minimum; and the net result is that with about 1,200 taps, of which


Office of LEXINGTON H. & M. CO.

LEXINGTON, KY. 189

Tap No. .....

Meter No. .....

RECEIVED OF ..... $

advance payment for Water to be delivered through Meter furnished by Company on premises .....

Sup't.

Fig. 1. Receipt for Advance Payment to Cover Cost of Meter.

480

METER RECORD.

TAP NO. 726 METER NO. 480 Mr John Smith No 18 N. Upper St 1 INCH METER

BROUGHT FROM PAGE .....

MONTHS	100	CUBIC FEET.	GALLONS.	RATE.	AMOUNT DUE.	AMOUNT PAID.	DATE PAYMENT.	REMARKS.
January.	561400							
February.	567400	6000	44883	25	10 10	10 10	Mch 1	
March.	586300	19300	144375	25	36 06	36 06	May 1	

Fig. 2. Part of a Page of Inspector's Book.

Mr John Smith No 18 N. Upper St

TAP No. 726 METER No. 480

	1,000,000	100,000	10,000	1,000	100.	10
JANUARY	5	6	1	0	0	0
FEBRUARY	5	6	7	0	0	0
MARCH	5	8	6	3	0	0

Fig. 3. Part of a Page of Meter Record Book.

1,000 are metered, one officeman and two outside men can easily do all the work, including setting meters and making new taps, except where an extension of a main line is made.

We make every tap and set every meter ourselves and make all collections with this force and have no need for any additional force except occasionally for some special purpose; but the working force at the pump house; two night and two day men, is not included in this statement. This economy of force and labor is accomplished by attention to a number of details, each of which is, perhaps, not so important by itself, but in the aggregate it amounts to so much that we think it less labor, and certainly far more satisfactory, to take care of and keep accounts with the 1,000 meters now in use rather than with the 200 consumers remaining under the old schedule system, and as fast as possible we are changing to the meter system entirely.

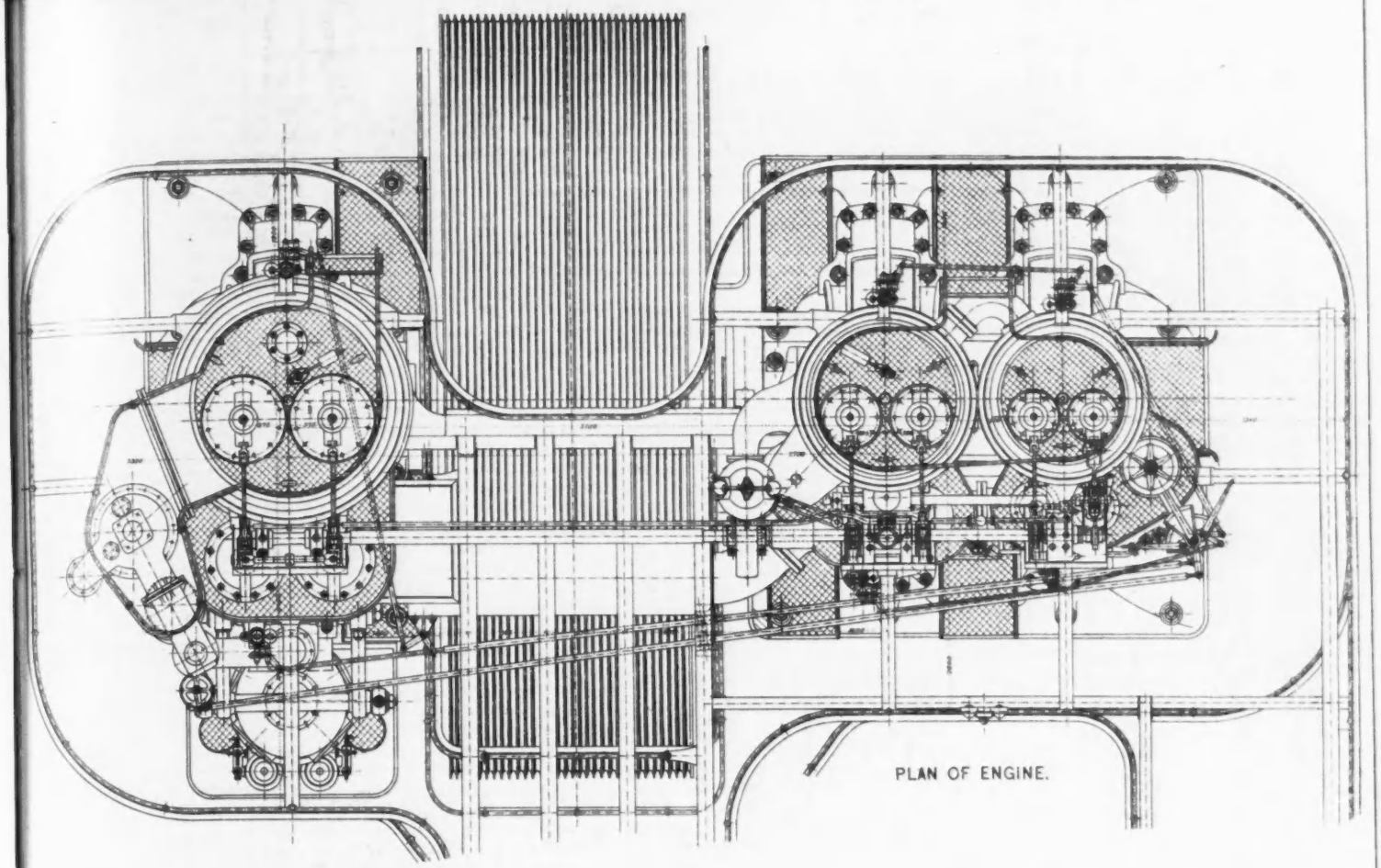
One of the principal objections to changing from the schedule system to the meter system, namely, the first cost, was obviated in our case by requiring every new customer to pay in advance for water a sufficient sum to cover the cost of the meter. This payment was not for the meter itself, which still remained our property, but an advance payment for water to be delivered through that meter at a minimum rate of 50 cts. per month. It is obvious that the advance payment would thus be exhausted in time, even if no water at all was used. In cases where the customer wants to discontinue its use from removal or other cause we refund or give him a rebate and use the same meter over again with another customer in the same way.

All new customers being thus metered, we have gradually put on meters on our schedule customers, beginning with those who wasted the most, until now nearly all our consumers are metered and the remainder will be as fast as we can conveniently do so. The form of receipt given for this advance water payment is shown by Fig. 1, reproduced from a blank form.

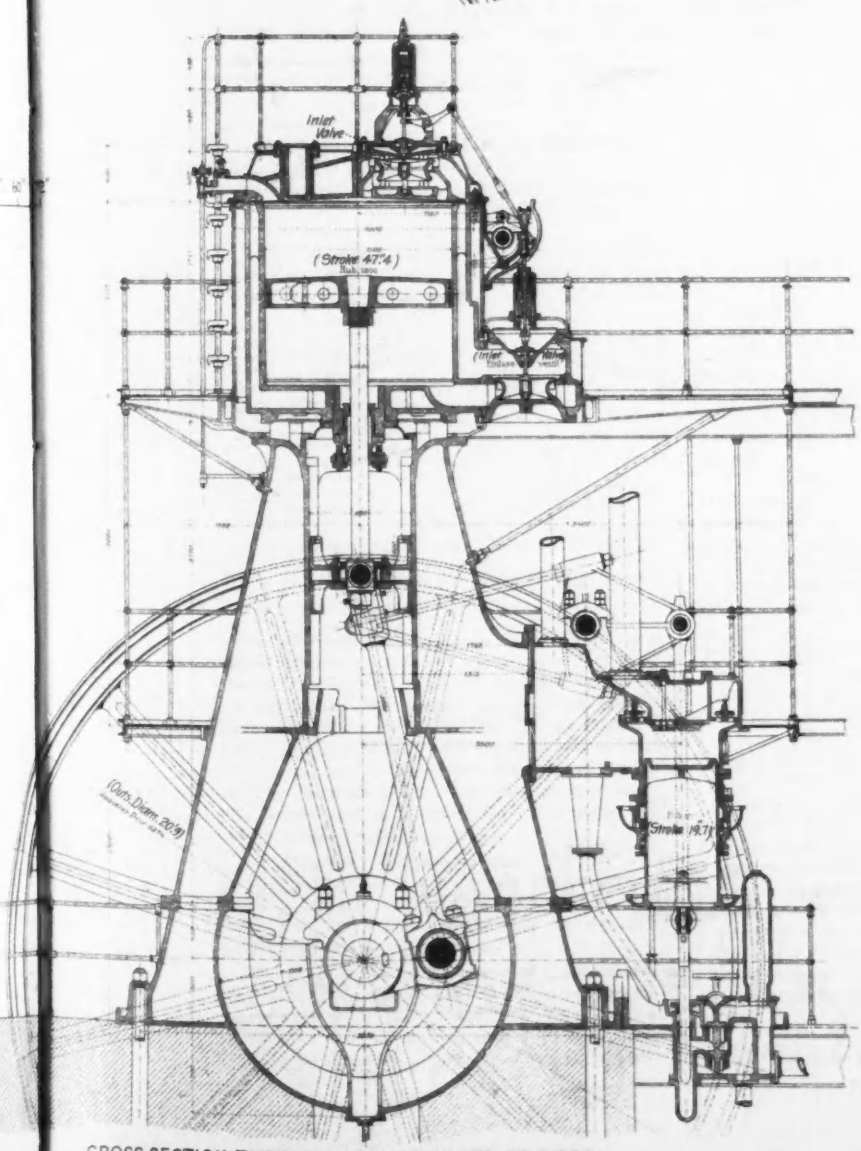
All meters are placed in the sidewalk just within the curb-line, 3 ft. below the level of the sidewalk, which in this climate is sufficient to guard against frost. We have never yet had one frozen when thus placed, although it happened frequently under

SIDE ELEVATION OF ENGINE.

LONGITUDINAL SECTION.



PLAN OF ENGINE.



CROSS-SECTION THROUGH LOW-PRESSURE CYLINDER.

TRIPLE EXPANSION VERTICAL ENGINE OF 1300 HP.

Sulzer Bros.,

Winterthur, Switzerland,

Builders.

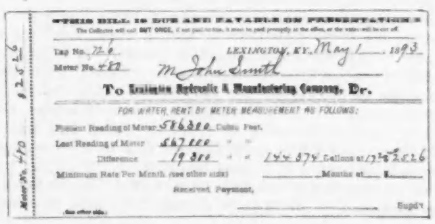
(All Dimensions in Millimeters.)

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.

the old plan of placing them in cellars. We use both the Crown and Hersey meters and get access to them by a cast iron meter box made for us by the A. W. Morgan Mfg. Co., of Buffalo, N. Y. This meter box is about 8½ ins. in outside diameter and is screwed up or down as needed to the level of the sidewalk in precisely the same manner as the ordinary screw stop boxes are adjusted. They were first made by the predecessors of the firm alluded to at the request of the writer and are now coming into general use. The inspector can take five times as many readings in a given time as he can where he has to go into cellars and climb over coal piles or run the gauntlet of dogs, and the meter is entirely in our control without the necessity of ever going onto a consumer's premises. In exposed locations the box can be stuffed with excelsior or other non-conducting material. We use also on all our meters extension pieces, as we call them, furnished by the Hersey Meter Co., with their meters, and probably by the National Meter Co. also, which bring the dials up close to the surface, so that when the meter cap is removed the reading is close to the eye. Before adopting the extension pieces we read by the aid of mirrors and reflectors, but find the extension dial system preferable..

The only objection I have been able to find against putting meters in the sidewalk in preference to buildings is that sometimes if they get set or stopped they have to be dug up, but this seldom happens, especially where a good filter is in use, and the cost of digging up is a trifle where the men are steadily employed and have ample time from their other duties. The advantages far outweigh the disadvantages. It is probable that in some northern portions of the country this sidewalk system might not be applicable on account of the depth to which it would be necessary to go to avoid frost, but up to 4 ft. in depth I would recommend it, and where a greater depth was necessary I would at least make the experiment and test it, as it is so much more satisfactory than the old plan.

We divide the city into districts or precincts, which we call A, B, C, etc., and we have record books for our inspectors' use which are correspondingly lettered. In each of these books is a list of all the meters in that district, one page being devoted to each meter and the book being ruled and headed for the readings for 12 months or one year. A page of this book, with the last nine months of the year omitted, is shown by Fig. 2. There is nothing specially new in this book or different from those in common use except that in the beginning of each of these books is a route list,


THIS BILL IS DUE AND PAYABLE ON PRESENTATION

Tap No. 72.6 LEXINGTON, KY., May 1 1893

Meter No. 542 Mr John Smith

To Lexington Hydraulic & Manufacturing Company, Dr.

FOR WATER RENT BY METER MEASUREMENT AS FOLLOWS:

Present Reading of Meter 576200 Cubic Feet.

Last Reading of Meter 567000 " "

Difference 9200 " " 144 874 Gallons at 1.50 per 1000 2.16

Minimum Rate Per Month (see other side) ____ Months at ____ $ ____

Received Payment, ____ Supdt.

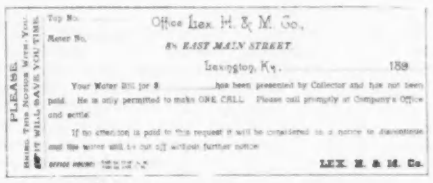
Meter No. 470 $2.16

Fig. 4. Bill and Stub for Meter Water Rental.

corrected from time to time as new meters are added, giving the order in which the meters in that district can be taken with the least amount of walking and labor. We also only read our meters to the nearest even hundred cubic feet, for the reason that anything closer is an unnecessary refinement, which will only make a few cents difference at best and will be corrected at the next reading, and also for the reason that a smaller table of gallons, prices and amounts, will be required.

The inspector commences near the end of the month with book A and when the readings are taken returns it, and takes book B, and so on, and the office man makes out the bills for one district while the next is being taken.

We keep all accounts and make all entries as far as possible by numbers and not by names, although we have the names to refer to whenever desired. Every meter, whatever its number, will always be found on a page of the same number in the meter record (see Fig. 3), and therefore in posting it is not necessary to refer to an index, for any payment on account of meter No. 200, will always be found on page 200 of the meter record and nowhere else, and even 1,000 postings can be made very quickly, because there are no names to write but only to turn to such a page and in the proper column put down so many dollars and cents, nothing more. Our collector, for example, takes out with him for collection bills Nos. — to — for a gross sum of blank dollars. All our bills (see Fig. 4; the reverse of this bill gives instructions for reading meter and meter rates) are made with a detachable stub on which is always written merely the number and amount and nothing more. As fast as a collection is made the collector detaches this stub, and when he makes his return to the office he simply returns these stubs for his report, and the amount of money he returns must correspond with the stubs. When unable for any cause to make a collection, he returns the bill with the proper stub


Tap No. ____ Office Lex. H. & M. Co.,

Meter No. ____ 85 EAST MAIN STREET.

Lexington, Ky., 189

Your Water Bill per 9 ____ has been presented by Collector and has not been paid. He is only permitted to make ONE CALL. Please call promptly at Company's Office and settle.

If no attention is paid to this request it will be considered as a notice to discontinue and the water will be cut off without further notice.

PLEASE Handle This Notice With Care. IT WILL SAVE YOU TIME.

LEX. H. & M. Co.

Fig. 5. Notice of Unpaid Water Bill.

still attached, and a notice is then sent to that person (see Fig. 5) to call at the office and pay. If he neglects to do so the water is cut off. If he calls at the office and pays, the stub is detached and the entry made from that, but all stubs, whether paid to the collector or at the office, are sorted in numerical order, as far as possible, without taking much time, and these numbers and amounts are then entered on the cash book.

In preparing the bills for collection we save labor by using a table already prepared which gives the number of gallons, price and amount in dollars and cents, for each even hundred cubic feet. It would be easy to extend the table to cover every ten or less cubic feet, but in practice it is not necessary. We have a sliding scale by which the large consumer gets a reduced rate, but we base our reductions in rates on the total monthly consumption and not on any averages or daily consumption, as is frequently done, and think ours the better mode and certainly more convenient. It may be well to remark here, that in any sliding scale system, there will always be a point where the consumer would sometimes get his water cheaper by even wasting a little so as to get the reduced rate on the larger consumption, but this is a trifling matter and may at least be partially obviated by making more and smaller steps in the scale if worth the while to do so.

The leading forms in use by us, shown herewith, will only be suggestive to others, for each one must adapt his form to his own special needs, but I think they show that by the use of a moderate amount of ingenuity the meter system can be made far preferable to the schedule system, regarded simply as a matter of convenience and satisfaction to water-works companies.*

We sometimes have complaints, as probably most companies do, that the meter must be wrong, that "they know they couldn't have used it," etc. We reply to these complaints that we will test the meter in their presence and if the meter registers against them their bill will cost them nothing, and we sometimes add that they may have their water free for the next six months, but in six years' experience we have never lost anything by these offers or failed to demonstrate that if there was any error whatever it would be certain to be a small percentage in their favor.

For testing meters, which we prefer to do on the consumer's premises, as it avoids all accusations of the meter being tampered with, we use a small portable tank, 2 × 2½ ft. × 2 ft. high, containing, of course, 10 cu. ft.

*The five figures accompanying this article have been photo-engraved and somewhat reduced in size from forms sent by Mr. Charles.—Ed.

SULZER TRIPLE-EXPANSION VERTICAL ENGINE OF 1,300 HP.

(With inset.)

American engineers have heard through various sources reports of the high records for economy attained by engines built by the firm of Sulzer Bros., of Winterthur, Switzerland. A 700-HP. engine built by this firm was tested by Professor Schroter, of Munich, and showed a steam consumption of only 12.73 lbs. per horsepower-hour, the steam pressure being 145 lbs.

We illustrate on our inset sheet this week a Sulzer engine built in 1891 for a textile factory in Moscow, Russia, to replace an engine built by an English firm. The general arrangement of the parts, including the vertical position of the cylinders and their grouping on each side of the flywheel, was adopted to suit the location in which the engine had to be placed. The principal dimensions of the engine are: Cylinder diameters, h. p., 26 ins.; i. p., 39⅜ ins.; l. p., 59⅛ ins.; stroke, 47¼ ins. The rated speed is 76 revs. per minute. The flywheel is 20 ft. 8 ins. in diameter and is grooved for 32 1¾-in. cotton ropes which are led to the main pulleys on the line shafts of the mill.

The main shaft rests on three pedestals cast on the base plate of the engine. The frames which carry cylinders and form guides for the crossheads are bolted to the base plate. All the cylinders are steam-jacketed. The valves are of the double-beat poppet type and are located on the cylinder cover for the upper end of the cylinder and beside the cylinder for the lower end. The valves are driven from an upper horizontal shaft, which is connected to the main shaft by a vertical shaft and bevel gears. The steam valves for the high-pressure cylinder have a trip cut-off regulated by the governor, and will cut off the steam at any point up to 60% of the stroke. The steam valves for the other cylinders have cut-offs adjustable by hand. The governor is of the flyball type and is driven directly by the vertical shaft which operates the valve gearing. This shaft is speeded to three times the number of revolutions of the main shaft, thus making the governor sensitive to small variations in speed.

An auxiliary safety governor on this vertical shaft comes into operation whenever the normal speed is exceeded by two revolutions per minute, and immediately trips the cut-off of the high-pressure cylinder and opens a valve admitting air to the condenser.

An injector condenser is used and the condensing water runs by gravity into a body of water whose surface is at a level 36 ft. lower. The air pump is single acting and is driven from the crosshead of the low-pressure cylinder by a rock shaft, which also drives the boiler feed pumps and the force pump which supplies the injection water.

We are indebted for the illustrations from which our inset sheet is engraved and for the matter from which the above description is prepared to the "Zeitschrift des Vereines Deutscher Ingenieure," the article being translated by Mr. W. G. Triest, Jun. Am. Soc. C. E. According to this journal, tests of this engine were made in December, 1893, and showed an average steam consumption of only 11.72 lbs. per I. HP. per hour, the water condensed in the steam pipe being deducted. This record was made with the engine developing 1,150 to 1,250 HP. and using steam at 150 lbs. pressure from Babcock & Wilcox boilers. The engine has developed at times as much as 1,500 HP., and is said to give perfect satisfaction to its owners.

Marble of fine quality was used some years ago in building the abutments and five piers of the Etowah River crossing of the Marietta & North Georgia R. R., near Canton, Cherokee Co., Ga. A correspondent, Mr. T. G. Baylor, says that the road passes through a country in which quarries of fine marble now abound, and this stone was used in the bridge by Engineer Wallace, of Cincinnati, because it was easily procured and cheaper than any other stone nearby. This item is now going the rounds of the press with the wholly erroneous caption of "The Only Marble Bridge in the World," and it is cited as a great curiosity. Marble bridges are really plentiful, and Mr. Baylor fully explains why this material was employed in this particular place.

BORINGS FOR THE BOSTON SUBWAY.

Some 18 borings have been made along the line of the proposed Boston subway, in material easy to penetrate for the most part. The depths reached were usually 25 ft.; at one point 38 ft. was reached.

The borings were made by driving down a pipe and taking out the soil from the inside. Samples of the earth were taken every 3 ft. A small derrick was used for pulling out the pipe and also for lifting the weight used in driving it.

The earth which was forced into the pipe was in turn forced out by water, and a small tube was inserted into the pipe for the purpose of taking out the samples.

The average number of samples taken at each boring was 12, which were placed in bottles and turned over to the commissioners. In some places the earth was found favorable and in other places unfavorable for the subway construction, but for the most part the result was favorable. Considerable water was found at some points, yet but little trouble is expected on this account, as on the whole the borings indicate fairly good ground and nothing to show that there will be any difficulty in carrying out the project.

The total time consumed in the work was somewhat over four weeks, there being many necessary interruptions of the work because of the pressure of the traffic which the subway is intended to relieve.

The Cunarder "Lucania," arriving at Queenstown on March 16, took the longer southern route, but covered 2,894 miles in 5 d. 13 h. 11 m. The hourly average, corrected, was 21.73 knots, a speed said to be as yet unequaled by an ocean steamer. The same ship made the western trip in November last at the average rate of 20.93 knots per hour.

The Metropolitan Traction Co., of New York, which lately offered $50,000 for a traction system superior to the trolley system, has practically settled down upon a choice between three systems. These are proposed by the Westinghouse Electric Co., the General Electric Co. and the firm of Siemens & Halske, the latter representing the system now in use in Buda-Pesth. Any company offering to put in a system under the terms of the competition must be prepared to fully equip at its own expense one of the numerous lines of the Traction company. Since the offer was first made, about 1,500 plans and suggestions have been sent in, many of the senders believing that they ought to have the $50,000 without the formality of a test.

The comparative merits of the asphalt used by the Vulcanite Paving Co. and the Pennsylvania Asphalt Paving Co. are to be tested by special experts appointed by the Philadelphia Trades League and the Franklin Institute, of the same city. This is an outcome of the late effort to have the specifications for asphalt paving so changed as to permit competition for this class of work in Philadelphia. The Vulcanite Co. now has a monopoly on paving with Trinidad asphalt. The Pennsylvania Co. uses Bermudez asphalt, from Venezuela, which, it claims, is equal to the Trinidad product. Director of Works Windrim has sent an expert to Venezuela to report upon the merits of the asphalt deposits there.

PERSONALS.

Dr. John H. Rauch, formerly president of the Illinois State Board of Health, died at Lebanon, Pa., March 24.

Mr. Henry Clay Jennings, M. Am. Soc. C. E., of Denver, Colo., died March 14. He was made a member of the Society in 1887.

Mr. W. S. Moore has been appointed Acting Engineer of Maintenance of Way of the Michigan Division of the Cleveland, Cincinnati, Chicago & St. Louis Ry.

Mr. W. J. Sherman has been appointed contracting engineer for the Toledo Bridge Co., for the southwest, with office in the Union Trust Building, St. Louis, Mo.

Mr. Dundas R. Wolff, formerly an engineer engaged on railway work in Chile, by the North & South American Construction Co., died at Santiago, U. S. Colombia, recently.

Mr. W. B. Leeds, Division Superintendent of the Pennsylvania lines at Richmond, Ind., has resigned, having been elected President of the American Tin Plate Co., of Elwood, Ind.

Col. T. W. M. Draper and his party of engineers, who went to Ecuador last November, have returned to this country, having completed their work of locating and erecting a placer mining plant for gold mining.

Mr. Geo. B. Burbank, Chief Engineer of the Cataract Construction Co., has resigned his position, the resignation to take effect May 1. As chief engineer of this company Mr. Burbank has had in charge the construction of the entire power plant at Niagara Falls, N. Y.

Mr. Martin L. Weaver, Chief Engineer of the Dayton (O.) Water-Works, died March 20. He was appointed assistant engineer of the Dayton works April 26, 18[illegible] and was promoted to engineer March 1, 1875, and resigned Feb. 1, 1882. He was again appointed May 1, 1887, and served until the time of his death.

Mr. Alexander Potter, Assoc. M. Am. Soc. C. E., civil and sanitary engineer, New York city, has taken into partnership Mr. A. P. Folwell, Assoc. M. Am. Soc. C. E., formerly assistant engineer with Mr. C. Ph. Bassett, of Orange, N. J., and in charge of the design and construction of sewerage and water-works. Mr. Folwell will take charge of Mr. Potter's Pittsburg office, recently opened.

Mr. H. Waller Bruckerhoff, M. Am. Soc. C. E., has resigned the position of principal assistant engineer of the Metropolitan Traction Co., which he has held during the construction of the Broadway cable railway, and will resume his practice as consulting civil and mechanical engineer, in the office of Mr. G. W. McNulty, 45 Broadway, New York city.

Mr. Robert Neilson Clark, mining engineer, died on March 17, at Pittsburg, Pa. Mr. Clark was born in Philadelphia in 1848, was educated at the University of Pennsylvania and began his professional career with the Pennsylvania Steel Co. After being for a time connected with the Lykens Valley Coal Co., he was selected in 1872 to develop the coal mines of the Denver & Rio Grande R. R. Co. and the Colorado Coal & Iron Co., and was later made manager of the Crysolite mines at Leadville, one of the largest properties of that famous camp. In 1887 he removed to Pittsburg and devoted himself to the development of the Bower-Barff process, and in 1892 he became a member of the firm of White & Clark, consulting engineers. Mr. Clark was one of the earliest members of the American Institute of Mining Engineers, and of the Engineers' Club, of New York city, and was for three years Secretary of the Engineers' Society of Western Pennsylvania. At the time of his death Mr. Clark was devoting himself to processes of the treatment of gold ores.

NEW PUBLICATIONS.

TYPHOID FEVER EPIDEMICS IN MASSACHUSETTS: Recent Investigations at Lowell, Lawrence, Newburyport, Chicopee Falls, Springfield, Somerville, Bonsville, Provincetown and Millville, Made By or Under the Direction of William T. Sedgwick, Ph.D., Professor of Biology, Massachusetts Institute of Technology and Biologist to the State Board of Health of Massachusetts. Reprinted from the Report of the Massachusetts State Board of Health in 1892; 8vo, paper; 78 pp.; with plates and figures. Printed for private circulation.

A number of the epidemics described in this report were due to infected water supplies, and as such are of interest to engineers and water-works men. The volume is handsomely illustrated by reproductions of photographs and maps in the form of plates and by diagrams in the text. The work as a whole has already been commended in these columns in connection with a review of the full report which appeared Nov. 30, 1893.

SIGNALS AND INTERLOCKING APPARATUS.—Report by W. H. Cole, Executive Engineer, India. 4to; pp. 31; plates 37.

This report, issued under the supervision of the railway department, is prepared from notes made of various plants inspected on European railways. There is little general discussion of the subject, but the several plants are described independently. For switch connections 1¼-in. wrought iron pipe is generally used, though the Midland Ry., England, uses solid round bar iron, and the London & Northwestern Ry., England, uses channel iron. Where signals are approached on a curve it is advised that lamps should be used showing a bright light over an angle of about 60° by means of differential lens. The apparatus described includes the specialties of Saxby & Farmer, Mackenzie & Holland, Stevens, and the Fazakerley works, as well as special features introduced by various railway companies. Reference is made to the Bianchi & Servettaz system of hydraulic working, which is in use in Italy. In regard to colored glass for night signals, it is stated that 50% of the light is absorbed by red glass, 80% by purple and 60 to 70% by green.

U. S. GEOLOGICAL SURVEY.—J. W. Powell, Director. New York and Vicinity, scale, 1-62,500; Albany and Vicinity, scale, 1-62,500. 1894. New York State Survey; the Port Henry and Elizabethtown sheets. Martin Schenck, State Engineer and Surveyor. Scale 1-62,500.

This excellent map of New York and vicinity covers an area extending from Hastings, on the Hudson, south to East Long Branch, on the Jersey coast; and east and west, from Rockaway, Long Island, to Cranford, New Jersey. Over all this area 20 ft. contours are shown in brown; all cities and towns are accurately plotted; water courses, roads, railways, etc., are laid down; tidal lands indicated, etc. The map is practically a compilation of the surveys made by the U. S. Coast and Geodetic Survey, the U. S. Geological Survey, the Geological Survey of New Jersey and those made by the New York city government. Mr. Henry Gannett was Chief Geographer, and Mr. Marcus Baker, the Geographer in charge. It is issued in the same excellent style as the well-known maps of the New Jersey Survey.

The map of Albany and vicinity extends from Saratoga Lake, on the north, to Castleton on the south; and from Raymertown, on the east, to South Schenectady, on the west. The detail of this map is the same in type as is the New York map, 20 ft. contours covering all this area. Mr. H. M. Wilson was the Geographer in charge. The two New York sheets conform with the above. The first includes Lake Champlain, from Bluff Point to Ticonderoga; and the second joins this one on the west, extending to Mt. Marcy.

NEW YORK STATE BOARD OF HEALTH.—Twelfth Annual Report. 8vo; pp. 558; tables and folding plates. Thirteenth Annual Report. 8vo; two volumes. Vol. I., pp. 736; tables. Vol. II., 27 folding plates. Lewis Balch, Secretary, Albany.

Although these reports are for the years 1891 and 1892, respectively, they were ready for distribution only a short time ago, owing, it is stated, to delays on the part of the printer. The report for each year contains the usual mortality statistics and routine matter and also plans and reports for sewerage and sewage disposal systems submitted to the Board by various municipalities during the year, as required by law. The third and fourth years' investigations of the Hudson and Mohawk rivers, in their relation to water supply, are described in some detail. Chemical and bacteriological studies of these streams are being made to determine the effect of sewage pollution, and facts regarding their so-called self-purification. Chemical analyses for the year 1891 were made by Prof. Wm. P. Mason, of the Troy Polytechnic Institute, and for 1892 by Prof. Willis G. Tucker, chemist of the Board. The report for 1893 contains some special investigations of the effect of sedimentation upon reduction of bacteria, especially in the settling basins of the water-works of St. Louis, Mo., and also an account of an attempt to distinguish between sewage bacteria and other forms by means of a fermentation method suggested by Dr. Theobald Smith, of Washington, and described by him in the report. It is thought that this method will prove to be a valuable one, since large numbers of bacteria have hitherto tended to condemn a water supply without regard to their origin, which might be harmless.

The engineering side of these investigations, and we judge to a considerable extent their general direction, has been looked after by Prof. Chas. C. Brown, formerly of Union College, but now city engineer of Indianapolis. The detailed bacteriological investigations have been made largely by Prof. J. H. Stoller.

It is to be regretted that these volumes should have been printed on very poor paper and bound not over well and also that the drawings for the folding plates were not so made as to permit of a greater reduction with much better effect, as they might well have been. The diagrams might have been improved upon both for clearness of understanding and convenience of reference. The subject matter of the reports is too valuable for reference to be presented in such a cheap and, we regret to say, somewhat slipshod manner. It is possible that there has been an aim to save expense in the publication of the reports for the sake of using the money in carrying on the investigations, but it seems true that a proper economy of space in tables and size of folding plates might have resulted in greater cheapness, even if the work had been better done. We trust that liberal appropriations will be made for the new investigations, as they seem to be dragging for lack of money.

DESCRIPTION OF A NEWLY DEVISED SANITARY BUILDING.—By W. Van der Heyden, M. D., Yokohama, Japan, 1893; pamph.; 21 pp.; photogravures and diagrams.

This is a curious speculation, well worked out, and actually put into practice by building the house described. He takes as his text the article by Flammarion, entitled "At the Death-Bed of the World," in which the last survivors are described as living in immense cities of glass. Dr. Van der Heyden anticipates the death-bed scene and suggests that we need not wait for the senility of the earth before "living in glass houses," for vast regions of the earth are now uninhabitable for us by reason of extreme cold. He then describes a glass house devised by him, which by reason of its construction and non-conductive qualities would make life bearable and even comfortable, not only in the arctic but in the extreme tropical regions of the world. Space forbids entering fully into the description of this peculiar abode, but it can be outlined as follows: The walls are constructed of glass boxes made of two thick sheets fitted in a cast-iron frame, and the space between filled with a solution of alum. The purpose of this solution is to separate the heat rays from the quicker, vibrating rays known as light, according to the discoveries of Melloni and Tyndall. These glass boxes are fitted closely to-

gether with felt between and form four solid walls, without doors or windows; and to prevent the freezing of the solution from outside air, or radiated heat through it from heating the inside of the house, ordinary window frames form air spaces within and without the house. The ceiling is made of double glass covered with a thick layer of ashes and the sloping wooden roof above this is covered with cement. The floor is of double planks saturated with paraffine with sawdust between. Access to this house is provided through the floor from an underground room of brick or iron plates, and several transparent boxes in the sides answer for windows. Dr. Van der Heyden makes elaborate provisions for filtering all the air entering and leaving this house; for heating it artificially; for destroying such microbes as enter with the occupant, and rendering harmless by burning all refuse and waste matter. His test house has been built one year and in that time the winter day and night temperature never differed more than 3½° C., and during an accident to his stove, with the fire out for 53 hours, the temperature in that time fell from 19° to 9° C. (66° to 49° F.), though it was freezing weather outside. Dr. Van der Heyden then goes on to speculate as to the result of not only building cities of such houses, but covering streets and gardens with the same impermeable glass roof and thus figures out, to his own satisfaction, that men could live comfortably in the arctic regions or in the Great Sahara itself.

CATALOGUE OF "A. L. A." LIBRARY; 5,000 Volumes for a Popular Library, Selected by the American Library Association and Shown at the World's Columbian Exposition; Pub. Doc. Bureau of Education; 8vo.; pp. 592.

Rarely, perhaps, has a more useful work been undertaken under government authority than this is likely to prove to be. Its general nature is tolerably well indicated by its title, and the library itself, of which this is the catalogue, was exhibited by the Bureau of Education in the Government Building at Chicago, where many of our readers must have seen it. The precise motive of the compilation is stated to be "to represent as nearly as possible the 5,000 books that a new library ought to obtain first for its collection." The final selection, of course an embarrassing duty, was made by a commitee of six prominent librarians, who sifted and finally passed upon the recommendations of some 75 librarians and specialists.

It will be evident that a list made in this way is likely to be very perfect for its particular object, which is to cover the whole range of human knowledge with only 5,000 volumes, so far as to contain some information on almost any subject of general or special interest, and to present all the great classics of literature which are often called for, keeping always in view the comparative demand for various books, which experienced librarians can judge with great accuracy. In such a limited collection it is practically essential to exclude all works, however popular, which lack real merit, and all works, however meritorious in their special fields, which are rarely called for.

It goes without saying, therefore, that such a catalogue is likely to be of much use to individual buyers of books, as well as to libraries, and we have no doubt it will be largely used in that way. The total retail price of the entire collection is $12,196, or some $8,000 at wholesale rates, indicating that it requires no very large fortune for even a private individual to have a pretty good library. It is somewhat disappointing to see that books relating to the "Useful Arts"—an enormously broad class—constitute only 5% of the collection against 29% in Fiction and Literature, and 27% in Biography and History. Still, adding Natural Science to Useful Arts, 12% of the collection is scientific, which is probably a very fair proportion for such library, and much larger than the proportional number of books drawn out by readers would warrant.

Among periodicals, a dozen or twenty of the leading unspecialized literary magazines are listed, but among scientific periodicals, only Engineering News, "Engineering" and the "Proceedings" of the Institution and of the American Society of Civil Engineers, to which are added two architectural papers ("American Architect" and "Inland Architect") and one railway journal ("Railway Age"), which is devoted largely to the operative side of railroading, and is a favorite among railway employes. The "Proceedings" of the American Institute of Mining Engineers are also included, but no other railway, mining, electrical or trade papers. This shows the care with which the selections have been made. It is, doubtless, without prejudice to the many excellent journals which are excluded, and which the committee would no doubt at once recommend for any large collection of periodicals, yet it will be seen by a moment's reflection that all the really salient and important developments in the applied sciences and scientific arts, which it would take a list of several hundred periodicals to cover completely, are pretty well covered by the brief list given, and more completely than could possibly be done by any other selection of periodicals.

TRADE PUBLICATIONS.

PUMPS: Illustrated Catalogue of Steam Pumping Machinery and Single Cylinder Independent Air Pumps and Condensers, as Manufactured by the Buffalo Steam Pump Co., North Tonawanda, N. Y. 12mo: paper; pp. 63; illustrations and tables.

Aside from full illustrated descriptions of the various kinds and sizes of pumps made by this firm some useful tables related to the subject are included in this catalogue.

SOCIETY PROCEEDINGS.

CIVIL ENGINEERS' CLUB OF CLEVELAND.—At the meeting on March 13 officers were elected as follows: President, Ambrose Swasey; Vice-President, J. N. Richardson; Treasurer, C. P. Leland; Secretary, F. G. Osborn.

INTERSTATE IRRIGATION CONVENTION.—A meeting was held at Omaha March 21 and 22, at which it is reported a large number of delegates were present from Nebraska, Iowa. Kansas, Colorado, Wyoming, Missouri and Montana. Papers were read and remarks made on irrigation and kindred subjects, among them being the following: Mr. J. J. Powell discussed the general subject of irrigation and water storage. Mr. J. S. Emery, National Lecturer of the association, made an address on the "Duty of the General Government in the Reclamation of the Semi-Arid Plains." Prof. L. G. Carpenter, Fort Collins, Colo., gave an address on "The Duty of Water." Mr. Elwood Mead, State Engineer of Wyoming, spoke on the "Progress of Irrigation in Wyoming." Resolutions were adopted in favor of congressional appropriations to test the practicability of irrigation from the underflow and for determining the extent to which storm water may be stored for irrigation.

WESTERN SOCIETY OF ENGINEERS.—At the meeting on March 7 the secretary read a paper by Mr. Hudson on "The Original Construction of the Burlington Bridge." The author had immediate charge of the construction of the original substructure as Resident Engineer under the late Mr. Max Hjortsberg as Chief Engineer. The science of bridge building has made great strides in the last quarter of a century, and the engineers of those days had little in the way of precedent to guide them, but the foundations and masonry as originally built were considered sufficient, with some comparatively inexpensive alterations and additions, to carry the new double track superstructure, as described in the paper recently read by Mr. Morison. Two of the piers at the westerly end of the bridge were built upon the shale which shows near low-water mark. The remaining piers were built upon pile foundations. The piles were driven with a heavy drop hammer, and cut off below low water; the sand was then washed out from among the piles to some depth by a water jet, and riprap stone deposited between and around the outside of the piles. The masonry was then built in caissons floated over the pile foundations and sunk in position. The paper was discussed as follows:

Mr. Geo. S. Morison.—Mr. Hudson is entirely correct when he states that there was very little work to do on the substructure of the Burlington bridge when it was reconstructed. The piers, excepting from deterioration they had sustained, were as good as they had ever been, and bear out all that he has said as to the excellence of the foundations. The piers were much larger than they had usually been built for the old single track bridges, and are double the size of those of the Quincy bridge, which was built at the same time. But in spite of the improvements that have been made in the manufacture of iron and in the manufacture of superstructures, I think that the present understanding of the method of putting in the substructure of similar bridges has led to almost as great improvements, and that if I had had, at time of rebuilding the Burlington, the problem of putting in an entirely new bridge at the same site, I do not think the cost of the piers, using precisely the spans as used, would have been half the cost of the superstructure. In a bridge which I am now building, across the same river, the foundations are all of the type of which the Burlington bridge was the first instance. They are all founded on piles cut off 10 ft. below low water, the piers built on rafts with movable sides above, so that they can be floated into position, located on those piles substantially as at the Burlington. The only advance in the foundations of the bridge built in 1893 over the one built in 1867 is in the method of doing the work, which has been very much simplified, and in that bridge, which has approximately the same dimensions as the Burlington, rather longer with a much heavier load, the cost of the superstructure is very nearly twice the cost of the substructure. This merely shows how the reduction of the cost of work under water, and of the cost of work above water, have gone on simultaneously, and really one of the greatest features of the Burlington bridge as originally built, as it is described by Mr. Hudson, the one that has done most to help building bridges across the Mississippi, was the fact that they succeeded in doing work under water without working under water. Their piles were driven from floating pile-drivers, their piles were cut off by machinery above water, the piers were built above water, any sub-aqueous work, excepting to the limited extent of examining foundations, was rendered unnecessary, and it was done there for the first time at the Burlington bridge. That feature has led to the present cheap form of construction of piers in rivers like the upper Mississippi, in which the current is so limited that it can very easily be controlled.

Mr. Goldmark thought that the fact that substructures proved to be longer lived than superstructures was evidence that there had not been so much false economy introduced in the design of substructures. The superstructures for bridges in this country to a very large extent have been built under the most severe competition, in which in many cases the object has been to build, not as good as possible, but as cheap as possible and still have it look something like a bridge. In substructures the engineer has had more to say than he has had in superstructures. In steel work and iron work it has not been the engineer who has developed the construction, but the contracting company and the shop. In other words, there has not been as close a watch on the bridge proper in actual use by competent experts as there is of other parts of engineering. There has been too great a division there, there has been too much office work done on bridge superstructures, without having office work supplemented by actual observation of the use of bridges during many years and under all sorts of circumstances.

COMING TECHNICAL MEETINGS.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
April 2. Secy., C. L. Annan, City Engineer's Office.
WESTERN SOCIETY OF ENGINEERS.
April 4. Secy., Thos. Appleton, Lakeside Bldg., Chicago.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
April 4. Secy., F. Collingwood, 127 E. 23d St., New York.
ENGINEERS' CLUB OF ST. LOUIS.
April 4. Secy., Wm. H. Bryan, Turner Bldg.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
April 6. Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
April 6. Secy., O. Von Geldern, 719 Market St., San Francisco.
ENGINEERS' CLUB OF PHILADELPHIA.
April 7. Secy., L. F. Rondinella, 1122 Girard St.
SWEDISH ENGINEERS' CLUB.
April 7. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 106 Randolph St., Chicago. Secy., C. T. Anderson.
WISCONSIN POLYTECHNIC SOCIETY.
April 9. Secy., M. F. Schinke, City Hall, Milwaukee.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
April 10. Secy., F. C. Osborn, Case Library Building.
NORTHWEST RAILWAY CLUB.
April 10. Secy., W. D. Crosman, Ryan Hotel, St. Paul.
NORTHWESTERN SOCIETY OF ENGINEERS.
April 10. Secy., D. W. McMorris, Burke Blk., Seattle, Wash.
DENVER SOCIETY OF CIVIL ENGINEERS.
April 10. Secy., F. E. King, Jacobson Block.
AMERICAN RAILWAY ASSOCIATION.
April 11. Secy., W. F. Allen, 24 Park Place, New York.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
April 11. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
April 11. Secy., F. M. Curtis, P. O. Box 1576, Boston.
AMERICAN SOC. OF MECHANICAL ENGINEERS.
April 11. Secy., F. R. Hutton, 12 W. 31st St., New York.
ENGINEERING ASSOCIATION OF THE SOUTH.
April 12. Secy., Hunter McDonald, Nashville, Tenn.
ENGINEERS AND ARCHITECTS' CLUB OF LOUISVILLE.
April 12. Secy., G. W. Shaw, Norton Building.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
April 12. Secy., C. H. McLeod, Montreal, P. Q.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
April 12. Secy., D. W. Meeker, St. Paul.
MONTANA SOCIETY OF CIVIL ENGINEERS.
April 14. Secy., G. O. Foss, Helena.
ENGINEERS' CLUB OF KANSAS CITY.
April 14. Secy., Waterman Stone, Baird Building.
ENGINEERS' CLUB OF MINNEAPOLIS.
April 16. Secy., E. Nexsen, 504 Kasota Block.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
April 17. Secy., Daniel Carhart, Pittsburg.
WESTERN RAILWAY CLUB.
April 17. Secy., Clement F. Street, Rookery, Chicago.
COLUMBIAN ENGINEERING SOCIETY.
April 17. Secy., F. W. Hart, Washington, D. C.
BOSTON SOCIETY OF CIVIL ENGINEERS.
April 18. Secy., S. L. Tinkham, 36 Bromfield St.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
April 18. Secy., J. A. Pilcher, Roanoke, Va.
NEW YORK RAILROAD CLUB.
April 19. Secy., John A. Hill, Temple Court.
ENGINEERS' CLUB OF CINCINNATI.
April 19. J. F. Wilson, 24 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
April 19. Secy., Howard Berge, 100 Washington St.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
April 19. Secy., S. A. Charpiot, Macon, Ga.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
April 20. 201 Washington Building.
CENTRAL RAILWAY CLUB.
April 25. Secy., S. W. Spear, Buffalo, N. Y.
MASTER CAR BUILDERS' ASSOCIATION.
June 12, 16. Saratoga, N. Y. Secy., J. W. Cloud, Rookery Building, Chicago.
MASTER MECHANICS' ASSOCIATION.
June 19, 23. Saratoga, N. Y. Secy., Angus Sinclair, Temple Court, New York.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York.
Entered at the Post Office, New York, as Second Class Matter.

VOL. XXXI. THURSDAY, MARCH 29, 1894.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS.
CHAS. W. BAKER, E. F. R. TRATMAN, M. N. BAKER,.....ASSOCIATE EDITORS.
GEO. H. FROST.....BUSINESS MANAGER.
F. P. BURT.....ASSISTANT MANAGER.

CHICAGO OFFICE: 1,636 The Monadnock.
CHAS. S. HILL.....RESIDENT EDITOR.
F. A. PECKHAM.....ADVERTISING MANAGER.

EUROPEAN AGENCIES:
KEGAN PAUL, TRENCH, TRUEBNER & CO. (Limited), Paternoster House, Charing Cross Road, London, Eng.
SAMPSON LOW, MARSTON & CO. (Limited), St. Dunstan's House, Fetter Lane, London, Eng.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00; single copies, 15 cents. To all other countries in the Postal Union, add $2.08 per annum (4 cents per number) to above prices for postage. No club rates allowed. Mailing addresses may be changed at will by sending both old and new address. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The date when the subscription expires is on the address label on each paper: the change of this to a subsequent date is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The need for a reform in the method of disposing of the pipes and wires beneath our city streets is a subject which has been often discussed, but which deserves to be agitated until some steps are taken to abolish the present wasteful system, or lack of system. The objection which is invariably brought up when the construction of subways is proposed is that the cost would be so enormous as to make the scheme prohibitory. The illustrated description of a large sewer recently completed in St. Paul, Minn., by Mr. Geo. L. Wilson, City Engineer, given on another page of this issue, sheds some light on this question of the cost of subways. As stated in the article, Mr. Wilson built a sewer nearly half a mile long, with a rectangular section 16 ft. wide and 12 ft. high at a cost of $60 per lin. ft., or $366,800 per mile. This work was done in made ground, where piling had to be driven to support the masonry walls, and at prices considerably above those ruling on large contracts in Eastern cities.

When one considers the cost of breaking through and replacing a modern pavement with concrete foundation, the injuries to pavement involved in such excavations, the cost of the deep excavations which continually have to be made in repairing and changing existing systems of water, gas, sewer and steam pipes and electrical subways, the waste due to leakage from the buried pipes of all the various systems, and the hindrance and obstruction to traffic caused by street excavations, it is clear that the public can afford to pay a round price for a proper system of subways, and would be the gainer by so doing.

As we pointed out in discussing this question recently, the practical obstacle is that cities and city streets are not designed and built like a machine or a structure, but have grown to their present state by a gradual development. The practical question, then, is how and where a start can be made in subway construction. In discussing this question recently an engineer of much experience in street work under ground suggested that as a first step in subway construction, an underground chamber should be built at every street intersection, covering the entire square between the corner curbs, and exposing all the buried pipes. By excavating one-quarter of the square at a time, the streets need at no time be closed. With the present low prices for steel, the beams and columns necessary for the roof and its supports would not be a heavy expense, and the facility with which pipes and fixtures could be handled in such a chamber, compared with the cost of handling them in narrow manholes or temporary excavations, would be an advantage of great importance.

The recognition of the germ theory of disease and of water as a carrier of infection from one person to another is presented in positive terms in a recent court decision published on another page of this issue, under the heading "Legal Decisions of Interest to Engineers." The decision is the result of a suit to test the legality of the New York act of 1893 relating to the sanitary protection of the Croton watershed, from which source is derived the principal water supply of New York city. In pronouncing the law valid the judge laid great stress upon the fact that sewage conducted into a water supply may be the source of widespread disease. This principle is coupled with the long established rule that, to quote from the decision, "It is the legal right of every riparian proprietor to have a stream of water which passes through his land flow in its natural condition with its channel unchanged and its purity unimpaired." The contamination of water supplies by sewage has been declared illegal by state laws and court decisions in many previous instances, but so far as we are aware it is at least rare in this country for a judge to go to the bottom of the matter and state in plain terms the gravity of the case in the light of modern sanitary science.

The new cruiser "New York," is one of the most carefully designed and successful of modern warships, and especially in the particular of maneuvering power, in which she is decidedly above the average. Yet as showing that she or any such ship would be almost helpless against any vessel of such high maneuvering powers as may be conceived of as attainable, although they have never yet been attained, the figures of her official tests are significant. The main feature of such a test is the "tactical diameter" or lateral distance in which the vessel can turn a complete circle, with the time required for doing so. The conditions for doing this best are quite different from what a landsman would imagine. To turn to starboard most quickly, for example, one might imagine that the proper course would be, after putting the helm hard a-starboard, to run the starboard engine full speed astern and the port engine full speed ahead. But instead of this being the case, it is found that the direct opposite gives far better results, the reason being, of course, the influence of the current issuing from the screws against the rudder. Almost as quick a turn can be made by merely keeping both engines running full speed ahead. There are three main ways of turning a ship quickly, in all of which the engine on the side to which the helm is turned is kept working full speed ahead, but the opposite engine is (1) also kept full speed ahead; (2) run half speed astern; (3) stopped. The last is somewhat the most effective, and in the "New York," the three compare as follows:

	Helm hard to: —Starboard.— Tact. Diam., ft.	Time, min. sec.	—Port.— Tact. Diam., ft.	Time, min. sec.
1. Both screws full speed ahead	1,200	5 25	1,050	6 01
2. Opposite screw half speed astern	1,125	5 51	1,050	5 58
3. Opposite screw stopped	1,050	6 48	825	7 20

It seems to us perfectly obvious from these figures that under the new conditions of large steam power, pretty good armor protection and perfect protection by rapid fire guns against boarding, speed and maneuvering power are going to count for far more than the guns in deciding future naval battles, which means that most of the existing ships will prove only traps for the unwary. We should mention that the "New York" can and did stop in less than her own length of 380 ft. and in 1 min. 46 sec. from full speed ahead of 15.93 knots, which is a remarkably good performance, and we must again admit that we can specify no particular means which give any positive promise of increasing maneuvering powers materially. But if maneuvering powers were as important to merchant ships as to warships, or if warships were fighting real battles every day or two, or every year or two, we cannot but believe that a way to secure maneuvering powers vastly better than those shown above would have been found somehow long ago.

The project of making continuous rails on electric railways by welding together the rail ends bears promise of proving successful, notwithstanding the difficulties which have been encountered. Briefly told, the history of this invention is about as follows: In the spring of 1892 a section of track 1,160 ft. long on the Johnstown, Pa., electric railway was made continuous by heavily bolted joints, the space between the rail ends being filled by a steel shim. Observations made on this rail during the summer showed that there was absolutely no kinking or buckling. The experiment was fully described by Mr. A. J. Moxham, president of the Johnstown Steel Co., at the 1892 convention of the American Street Railway Association (Eng. News, Oct. 27, 1892). The success of this experiment induced Mr. Moxham and his company to go farther. A special machine was built by the Thomson Electric Welding Co., and a contract was entered into with the West End Street Ry. Co. to weld the rails on 16 miles of track in Cambridge, Mass. This work was done by removing the fishplates and attaching fishplates of special design, which were electrically welded, first to one rail and then to the other. We understand that this experiment was not wholly successful, as a tendency developed to break at the weld when traffic on the track was resumed. It is claimed, however, that this was due to causes which have now been overcome, and that contracts have been made for welding 3½ miles of rails on the Baden & St. Louis Ry., at St. Louis, Mo., now being altered from horse to electric traction, and that other large contracts are pending. The advantages of a continuous rail lie not alone in the abolition of the joints, the cost and maintenance of which have become a more serious problem on electric railways than they ever were on steam roads, but in the low resistance path which a continuously welded rail offers for the return current, and which it is hoped will prevent this current from doing further mischief to the underground pipes.

The need for careful installation of interior wiring, for electric light or power, according to strict plans and specifications, has been emphatically illustrated by two recent fires. On the morning of March 18 the Union Depot at Denver, Col., a structure on which nearly half a million dollars had been expended, was destroyed by fire. Concerning the cause of the fire, it is stated that it was first seen in the room of the telegraph operator of the Denver & Rio Grande R. R. There was trouble with the electric wires during the previous evening. Fixtures had been burning out, and arc lamps had been showing signs of a deranged circuit. About 11 p. m. an electrician was summoned and made an inspection, but failed to locate the source of the trouble, and in a half-hour or so the fire broke out. Three days later in St. Louis the electric power station and car barn of the Missouri R. R. Co. was burned to the ground, the fire being caused by a bolt of lightning entering the station over the wires.

Undoubtedly there has been, and still is, considerable unjust prejudice against electric light and power on account of danger from fire. It is now generally conceded by those qualified to judge that electric lighting, when properly installed, is safer than any other system. But when interior wiring is not properly done, and when the well known and well proved precautions against accident are not taken, the system becomes peculiarly dangerous, because the points where the fire is likely to start are as a rule concealed, and because fires from such a source are not suspected or watched for by those in charge of a building. The National Electric Light Association and the underwriters have formulated standard specifications for interior wiring, designed to afford security from fire. Any one who permits interior wiring to be installed under less rigid requirements should fully understand what risk he runs in so doing.

ABOLISHING THE COAST AND GEODETIC SURVEY.

What particular and personal grievance Congressman Enloe, of Tennessee, has against the U. S. Coast and Geodetic Survey, it is impossible for us to say; but his proposition to abolish this bureau and divide up its duties among several departments seems to be very unwise, to say the least. The reasons which he gives for this action would also indicate a very meager acquaintance with the true purpose and methods of this important branch of the public service. Mr. Enloe says that the survey of the coast line is incomplete and that the bureau has not materially extended the 35th parallel survey for which "$15,000 was appropriated in 1871." He also objects to the field officers of the survey spending their summers on the coast of the Atlantic, "where it is pleasant and agreeable," and then coming to Washington for the winter months, presumedly for the only reason that that city is then "more agreeable" than the sea coast. He complains that "we are spending more than a million dollars for every inch added to the accuracy of the measurement of the earth's surface;" and he further charges that the men controlling the survey are using the money appropriated to coast survey work for accurate local state surveys never contemplated when the bureau was organized.

To a "practical" man of Mr. Enloe's bent of mind, we doubt not but that the whole subject of any increase in our accurate knowledge of the territory of the United States is a wholly unnecessary refinement. It is quite true, as he says, that the Coast and Geodetic Survey is now engaged upon many problems not contemplated when the bureau was organized by Thomas Jefferson—in 1807. But he should also remember that conditions and requirements have materially changed in the intervening eighty odd years, and that in 1878 the bureau was reorganized with a special view to the furnishing of "geographical positions and other data" to state surveys; the very work to which he now objects. We have no data for testing the correctness of Mr. Enloe's statement that this bureau has expended "nearly $30,000,000" in the 87 years of its existence, or an average of about $345,000 per year. But even if these figures are true, it is also true that no other government has carried forward so thorough and accurate a system of surveys over so large a portion of the world's surface as has the United States. The area covered by the surveys on the Atlantic coast is 28,950 sq. miles; on the Pacific coast, 5,280 sq. miles; in Alaska, 720 sq. miles, and resurveys amount to 2,450 sq. miles. This represents a total of 37,400 sq. miles of surveys spread over an area that is 3,835 statute miles wide, east and west, and is 4,224 miles between the extreme north and south points in the system of surveys.

As "the pleasant and agreeable" summer months are usually selected the world over for the field-work in the coast survey, as in other surveys, the officers of the Coast and Geodetic Survey must probably plead guilty to the charge that they spend these months on the Atlantic coast; and as the collating of field notes, calculations, mapping, etc., are usually best done at headquarters, they must also plead guilty to remaining at the Washington headquarters of the bureau during the winter. It is also altogether probable that the field officers work no faster, when at work, than do the majority of men in permanent government employ; and while others besides Mr. Enloe might desire to see these officials struggle a little harder for their salaries, it is difficult to understand how this desirable end is to be secured by simply dividing up the duties of the Coast and Geodetic Survey between the Navy and Interior Departments. Human nature is much the same in all departments of the government. Besides this, the extremely accurate nature of the work of making a survey, the important effect atmospheric conditions have upon the results sought for, and the extreme care required demand slow, rather than hasty work, and methods which Mr. Enloe would undoubtedly regard as "trifling and wholly unnecessary" were he at the head of the survey—which, fortunately for exact science, he is not. It is especially in the establishment of a primary system of triangles, involving in some cases 190 mile sights and longer, that care and patience are necessary. All accurate surveys of this character require time, and to unduly "hasten" them is the reverse of economical.

As to our coast line surveys, those on the Atlantic coast are so nearly completed that all practical purposes are now fairly well served, as the line of triangles extends from the eastern boundary of Maine very nearly to the Gulf. And the same may be said of our Pacific coast, excepting our newer possessions in Alaska. Of late years the bureau has been giving very valuable aid to state surveys along the Atlantic coast, utilizing for this purpose the primary triangulation of the coast survey; and as a result of this co-operation of the national and state governments we have the extremely complete and satisfactory maps of New Jersey; and similar maps for New York, Connecticut and Massachusetts are either already being published or are well advanced. Notwithstanding Mr. Enloe's objection to this "local p rversion" of public funds, it would seem to be to the interest of the government, quite as much as to the several states, to have this work done speedily and well; and this co-operation in surveys has the decided advantage of having all state surveys founded upon and exactly agreeing with the elaborate and costly surveys made first for the government. It is only when this system is extended to all the states of the Union that the United States Government will possess an accurate and complete map of its wide domain, and such maps are now much needed by every department of the government for the proper transaction of department business.

If any change is made in the conduct of work now under the control of the U. S. Coast and Geodetic Survey, it should come in the form of an entirely new department in the government, a Department of Public Works, under which should be consolidated much work now scattered among the War, Navy, Treasury and Interior departments. There would be a very conceivable advantage in this disposition of the question; but there is little or none in the separation of work proposed by Mr. Enloe. One of the arguments advanced by him, and seconded by Mr. Carlisle, is that there would result "a considerable reduction in expenditures and it would prevent duplication of works." We doubt this, if two heads, the Secretaries of the Navy and Interior Departments, are to be substituted for one, the present efficient and trained head of the U. S. Coast and Geodetic Survey. The work under the control of this bureau is eminently technical work, very different from that falling to the lot of the most capable cabinet officer, and to put this cabinet officer in charge is simply to shift responsibility from one bureau officer to another, for to a bureau it must necessarily go, if any good is to result.

But if a new department were created, as here indicated, and all public surveys and engineering work of every description were concentrated under one department head, a cabinet officer selected for scientific and engineering acquirements, there should be a gain in efficiency and economy. Special bureaus in this department would naturally subdivide the work; but they would work together, and not independently, as now. Coast surveys, geological surveys, meteorology, harbor and river improvement, the public buildings of the country and all work not of a strictly military nature, would then be united under one control, and it is a question whether it would not be better for the country if forts, lighthouses and docks were also included. Officers trained by the government could be detailed to superintend this special work under the new department, quite as well as by the several departments now using their services. Engineering has now a more marked and widespread influence upon our national prosperity than any one other feature, and it enters so frequently into questions of governmental discussion and consideration, that it is time our department organization was brought up to date by the creation of a department capable of handling intelligently engineering matters. Nearly every other great nation already recognizes this fact, and the United States should now realize that radical changes have taken place since its government was organized, and that a change of the kind proposed would be beneficial. Until this is done, it is idle for Mr. Enloe, or any other man, to propose any change of control in public works which simply shifts this control from one pocket of Uncle Sam's breeches to two pockets in his waistcoat.

LETTERS TO THE EDITOR.

ERRATA IN "CLEANING AND SEWERAGE OF CITIES."

Sir: Please add the following error to your list published Feb. 22 of errata in first edition of Baumeister's "Cleaning and Sewerage of Cities:" Page 35, second formula:

$$C = a - \frac{a\,b}{b + \sqrt{r}} = \frac{a\sqrt{r}}{b\sqrt{r}}$$

should read

$$C = a - \frac{a\,b}{b + \sqrt{r}} = \frac{a\sqrt{r}}{b + \sqrt{r}}$$

Yours truly, Edwin Duryea, Jr., C. E.

Carmel, N. Y., March 3, 1894.

(We have also received from Mr. Ira C. Otis, of Anacortes, Wash., the following corrections: On page 2, in line 10, "1.83 ft. per minute" should read "1.83 ft. per second." On page 3, in line 1, "a maximum grade of 0.2%," should read "a maximum grade of 2%."—Ed.)

FAILURE OF A CANADIAN BRIDGE.

Sir: The inclosed clipping is from the Ottawa "Evening Journal," and I know it from other sources to be true. It furnishes another evidence of the "wisdom" of village councillors building bridges without employing an engineer. A bridge firm in Montreal took the contract for the whole bridge, and sublet the masonry work. The specifications were good, but with no one who understood them to oversee the work, the subcontractor used a very poor grade of common lime instead of cement, and even with that did very bad work. Casselman is a village on the Canada Atlantic Railway, 30 miles east of Ottawa, and the bridge referred to was a highway bridge built by the village.

Yours very truly, E. T. Wilkie.

Almonte, Ont., March 21, 1894.

(The "wisdom" to which our correspondent refers is properly described as "penny wise, pound foolish." The clipping inclosed is as follow.—Ed.):

Casselman, March 19.—The water is very high in the Nation River, and the ice began moving yesterday. About 10 o'clock last night two spans of the new bridge were carried away, one span being taken completely over the High Falls, the other stopped at the island below the bridge. The cement in the piers is not good and has been giving way ever since the water began to rise, making the stones so loose they were constantly falling out. The village council is blamed for not employing a mechanic to superintend the work while the bridge was in construction.

COMPARATIVE EFFICIENCY OF SCREW PROPELLERS IN WATER AND IN AIR.

Sir: You may have noticed that I sent an article on the air propeller (with which I have propelled boats here) to the Engineering Congress at Chicago. As a matter of interest, which also illustrates the principle of the conservation of energy, it should be noticed that a propeller in water and a propeller in air, the latter having the shape explained in my paper and six times the diameter of that designed for water, give practically the same thrust when the engine power is the same in both cases. There is, however, a little plus on the side of the air propeller, because, on account of the elasticity of the air, the losses are smaller. If, for example, one of the best tugboats in New York is examined, a thrust of, say, 40 lbs. per I. HP. will be found, when the tug is tied to a dynamometer and without forward motion. Just the same thrust, 40 to 45 lbs. per I. HP., is delivered from an air propeller under the same circumstances; and it can readily be proved that, by aeroplanes or any other contrivance, a greater thrust cannot practically be obtained. Yours respectfully, H. P. Vogt.

Holsteinsgade, 31, Copenhagen, Nov. 2, 1893.

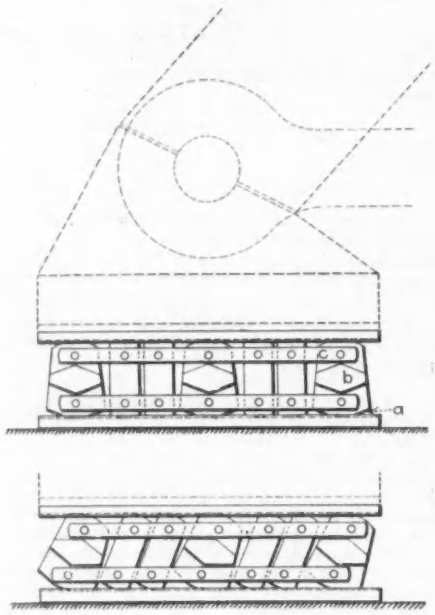
(It seems as if the thrust in pounds was a rather dubious measure of the efficiency of the respective screws in transmitting foot-pounds, and for this work it is not quite clear whether an elastic or inelastic medium is preferable. For example, despite these comparative thrusts, is it true, or anywhere near true, that by changing a tug's engines so as to drive an aerial instead of a submerged screw, the same horse-power will exert the same propelling effect upon the hull? We apprehend not.—Ed.)

NON-TIPPING SEGMENTAL BRIDGE ROLLERS.

Sir: Segmental rollers have been used for such a long time in Europe that it is a wonder they have been so neglected in this country.

In designing some, for several 300-ft. spans, it became desirable to add some unpatented device to prevent tipping. To accomplish this the writer made

every third roller with a flat face "a" on each side of the curved face and tangent to it. Should the bridge tip the rollers to the extreme shown in the lower view, three flat faces come on the bed plate and prevent it tipping further; the curve on top of



An Expansion Bearing with Segmental Rollers.

these rollers is made wider faced to give a bearing at the extreme position.

As an additional safeguard, the end of each of these odd-shaped rollers extends out, lozenge shaped, and should it tip beyond the flat face on the bottom, the shoulder of this extension "b" will strike against the spacing bar "c" and give a final and positive lock, should the face "a" fail to accomplish this.

The spacing bars "c" can be made of any size required for strength and firmly fastened to the rollers. There is no patent on this device.

C. E. Fowler, Assoc. M. Am. Soc. C. E.,
Chief Engineer Youngstown Bridge Co.

Youngstown, O., March 20, 1894.

RESPONSIBILITY FOR THE ACCIDENT ON THE KNOXVILLE WIRE ROPE TRAMWAY.

Sir: The great publicity given to the breaking of the aerial wire rope tramway in Knoxville, Tenn., by your paper in your issue of Feb. 22, as well as by several others, has given rise to many inquiries from people who suppose that this wire rope tramway was one of our cableways. We think it only justice to us that you should state that this passenger ropeway was entirely unknown to us, until we read of the deplorable accident occurring on account of the breaking of the half-inch rope. If the dimensions given in the papers are correct, we would feel disposed to criticise the selection of so small a rope for so heavy and responsible a duty. Lidgerwood Mfg. Co.

New York, March 20, 1894.

THE PROPOSED VIRGINIA ROAD LAW

Sir: Referring to your criticism in Engineering News of March 1 of the proposed road law for Virginia, which was prepared by the Association of Engineers of the state, we are constrained to conclude that your inspection of the proposed law must have been of a superficial character. You say: "We see no attempt at the exercise of engineering authority over those who are to actually build the roads, bridges, etc."

Sec. 9 provides that "The District Engineers shall, under the control and direction of the State Engineer, have direct charge of all state engineering work in their respective districts."

Sec. 10 provides that the county engineers shall have control in the county or counties for which they are appointed, under the control of their respective District Engineers. Sec. 21 provides that whenever it is deemed expedient by the State Engineer to construct or repair any road or bridge over which, by reason of this act, the state shall have control or supervision, the State Engineer shall advertise in some paper published within the county in which the work is proposed to be done; and if there is no paper, he shall advertise by notice posted on the door of the Court House, and invite sealed proposals for furnishing the material and for doing the work necessary for the construction of the proposed work. After such notice shall have been posted for 30 days, all proposals shall be opened by the State Engineer, and the work shall be awarded to the lowest responsible bidder; or, if the State Engineer may deem it to the best interest of the state so to do, he may, without advertising, where the cost of the work does not exceed $500, purchase the necessary materials and execute the work by day labor.

Sec. 12 provides how roads shall pass into and under state control, and constitutes the State Engineer the final arbiter as to such "classification and designation," the functions of the Supervisors in this respect being merely recommendatory.

Now, as to engineering authority over those who actually perform the work, as the State Engineer really determines where and what work shall be done, it becomes a mere matter of detail and specifications to be determined by the State Engineer under the authority of Sec. 4 to exercise such authority and control of all work done by the state as, in his opinion, he he may deem expedient and in conformity with the act. It is contemplated that in some counties more money will be expended on roads and bridges than will be provided by the specific state road tax through the action of the counties themselves, and Sec. 13 provides that such counties, cities and towns may have the advice of the State Engineer in such matters without charge. It is difficult to see how more authority and power could be conferred upon the engineering department, as it must decide (1) what is under state control, (2) how much and what nature of work may be executed upon all or any portion of it, (3) by whom the work is to be done, (4) in what manner it shall be done, and, lastly, under Sec 18, whether the accounts for such work shall be paid.

It is provided that the State Engineer shall be appointed by the Governor for his term of office, which is for four years, instead of three, as stated in your criticism, but it does not follow that a competent engineer could not succeed himself, and we believe that the knowledge of this prerogative of the Chief Executive of the state would be an incentive to the incumbent engineer to put forth his best efforts in the interest of the state.

As to dispensing with the District Engineers, it seems opposed to all practice in engineering organizations. It may as well be recommended that the Division Engineers in railroad practice be dispensed with, and that the Resident Engineer report direct to the Chief. Our proposed organization is founded on the test of practice, but if good reasons can be adduced for such radical changes, we are willing to admit them.

Now, as to engineering authority over those who which you recommend to take the place of the Engineering Department, the difference is infinitesimal. As we take it, in either case certain engineers must be appointed, vested with proper authority to carry out certain means to arrive at definite results.

We are willing to admit the truth of the closing section of your criticism, that the practice of most of the legislatures of states is to leave the matter entirely in the hands of counties themselves. We may say, " 'Tis true, and pity 'tis 'tis true," as you particularly admit when you say that the present system "would seem to be best adapted to immediate needs, and may be supplemented by State Engineers and state highways as the public becomes better educated to the needs of the case." Educating the public to the needs of the case is what the Association of Engineers of Virginia has been attempting to do in the formulation of the law in question, and as you allow that the case has needs which may in future be remedied, by State Engineers and state highways, then we may "lay the flattering unction to our souls" that we have not been slow to perceive the need and suggest the remedy.

In conclusion, we do not believe that you intended any unjust criticism, and we feel convinced that a second careful reading of the proposed road law will result in an amendment of the editorial in your issue of March 1.

Clarence Coleman,
Chairman Com. on Road Laws.

Roanoke, Va., March 8, 1894.

(In reply to Mr. Coleman's criticism of our criticism we must admit that in the rush of other matters our reading of the bill was not as close as was desirable. Sec. 22, which provides for the levy of a specific state tax, to be devoted to "the expenses of constructing, repairing and laying out highways and bridges," was wholly overlooked, and the first part of the Section, devoted to "the expenses of the organization herein provided for," was alone considered. With all roads, outside of municipal boundaries, under engineering supervision, untrammeled by local authorities, and the means to construct these roads provided for by a special state tax, nearly all of our criticism of the bill falls. And under the new reading this must be assumed to be the real purpose of the bill. As a bill for state roads and their construction and maintenance by the state, it now meets our approval. What the county officials will have to say to the abolition of all their power is another question. Our whole criticism was based upon a possible conflict between the State Engineers and these local officers, who were supposed to provide the means of execution, as we first read the bill.—Ed.)

CONCERNING A LABOR-SAVING DEVICE.

Sir: As I know you are always interested in labor-saving devices, I herewith inclose photograph of a successful method of dumping carts used on the grad-

A SUCCESSFUL METHOD OF DUMPING CARTS.

ing of the college athletic grounds here. Hoping this may prove a useful hint to contractors, I remain,

Very respectfully, L. A. Francisco, C. E.

Easton, Pa., March 16, 1894.

FIELD NOTES FOR BEGINNERS ON A SURVEYING CORPS.

Sir: Perhaps the following notes from my field book may not be wholly without practical value to some exuberant youths whose sole experience in field work has been gained in staking out imaginary lines on a college campus. Yours truly, Robert Freezes.

Louisville, Ky., Feb. 19.

To the Rodman: You are supposed to carry a level rod and a hatchet. The rod is used that the levelman may have a chance to look at it through his glass and so earn his salary. It is also used to clinch arguments with the angry dogs of the farmer through whose lands you are passing. To use it as a cane or a sounding rod in swamps will also promote accuracy, and it is well also to cut your initials on various places on it to pass away the time while the leveller is adjusting his instrument. You will find the leveller a very pleasant fellow and always fond of a joke. You will please him greatly by waving your rod wildly while holding it at stations, or, better still, by holding it upside down, at the same time laughing in a boisterous manner.

To the Head Chainman: You are to carry a nice red and white pole; these colors you will note come within one of comprising those of the flag of our country, and

you can easily so conduct yourself that the transitman will complete the combination by tinting the atmosphere with the third color. You will also carry one end of a chain or steel tape, the rear chainman being attached to the other end. You are at liberty to boss the rear chainman all you please, and it is good sport to jerk him off his feet when he is picking his way across a brook or swamp. When you are 1,000 ft. or so in advance of the transitman it is a good plan to go back to him and borrow some tobacco; this shows you bear him no ill will.

To the Rear Chainman: You are to "talk back" at the head chainman whenever he addresses you, and otherwise get even with him by throwing him off his balance every hundred feet by a quick, dextrous jerk of the chain.

To the Axeman: Don't make stakes so that they can be easily marked; it assists the corps to get ahead too fast. Playfully notch the level rod, instrument legs, etc. If possible go back and obliterate the bench mark made by the rodman.

To the Rear Flagman: When you arrive at the "hub" the transitman has left, note carefully the position of the tack, and if not exactly in the center of the "hub" correct accordingly; this is important.

NOTES AND QUERIES.

N. wishes to know who manufactures sewer manhole covers with locking device. In Engineering News of May 25, 1893, there was illustrated and described a locking cover in use at Colorado Springs, Colo., patented by Mr. H. C. Lowell, of Denver. Mr. H. I. Reid is city engineer of Colorado Springs. A locking device at Salt Lake City, Utah, was described in our issue of Jan. 4, 1894, regarding the manufacture of which Mr. A. F. Doremus, formerly city engineer, may be able to give information.

F. M. J. inquires where he can obtain information as to the process of extracting tannin from the plant called "canaagri," or "canaigre" (sour cane). The plant is abundant in New Mexico and is said to contain a large percentage of tannin.

FAILURE OF A MASONRY FLUME.

An accident occurred at the water-power electric station of the Vermont Electric Co. on the Winooski River, near Burlington, Vt., on March 8, resulting in the wrecking of part of one wall of the power house and the fall of the roof. We are indebted to Mr. J. M. Evans, C. E., of Burlington, Vt., for the information from which the following description of the accident has been prepared and for a sketch from which the accompanying sections have been drawn.

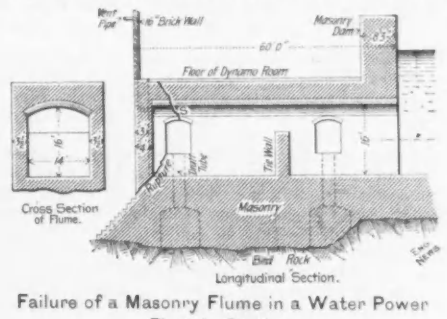
The power station is built below a dam which extends across one channel of the river, and rises above high-water mark, the overfall being over a dam in the opposite channel. Two masonry flumes extend beneath the power station and conduct the water to the turbines. These flumes were built with stone masonry laid in Portland cement mortar, and in the sequel appear to have showed a strength of which the builder of the masonry and the maker of the cement may be justly proud. The east flume, which failed, furnishes the water to a 625-HP. turbine for the electric light plant and a 350-HP. turbine, which drives a railway dynamo. The west flume contains one turbine of 625 HP., which is held in reserve.

The plant was completed and put in operation last fall; but we believe that up to the time of the recent accident it has not been subjected to high water. At that time, however, owing to the melting of the snows and the break-up of the ice in the river, the level of the water above the dam was about 5 ft. above its usual height. This of course materially increased the hydrostatic bursting pressure on the masonry flume. The company, however, ascribe the final failure to the freezing up of the vent pipe, an 8-in. pipe, shown in the sketch, extending from the flume to a point above the level of high water, and open at the top. The purpose of this vent pipe was to relieve the flume of the water hammer produced by the sudden shutting down of the railway dynamo, the load on which fluctuates between zero and 200 HP. within a few seconds, and necessitates the rapid opening and closing of the turbine gates.

The railway dynamo is shut down from midnight to 5 a. m., and it is stated that during this shutdown on March 8 the vent pipe was frozen. The wheel was started as usual, however, and after running about three hours the workmen noticed a slight leak in the masonry of the side wall of the flume, directly over the arched opening provided for the draft tube castings at the point marked S in the sketch. It was considered of no importance at first; but two hours later it had increased to such a size that the constructing engineer was sent for. Immediately on his arrival orders were given to shut down the wheel; but before this could be done the end of the flume was forced out, carrying with it that portion of the building wall which rested upon it, the roof falling down like a trap door upon the dynamo floor and machinery. About half of the wall on this side of the building remained intact, preventing any injury to the other flume. None of the dynamos or other machinery were injured.

As seen by the accompanying sketch, the flume was a masonry chamber 14 ft. wide and 16 ft. in height, subjected to the internal pressure produced by a head of water of 17 to 18 ft. at its center, according to our best information. The side walls of this chamber were 3½ ft. thick and the wall which closed the end of the chamber was 4 ft. thick.

Our correspondent states that the masonry was heavily rodded, the rods being 1⅛ to 1¼ in. in diameter; but we are not informed as to the number or location of these rods. Apparently they must have been numerous and well secured, or the masonry could not have withstood so long as it did the enormous load produced by the hydrostatic pressure. Taking the head as 17½ ft. at the center of the flume, it appears that the average pressure against the 4-ft. end wall, 14 ft. broad and 16 ft. high, was 1,093 lbs. per sq. ft., or about 230,000 lbs. in all.



Failure of a Masonry Flume in a Water Power Electric Station.

It is of interest to note that the account of the accident published in a local newspaper stated that the disaster was not caused by the high water (the river being some 5 ft. above its ordinary stage), but "to the increased density of the water at this season of the year"—an explanation which is certainly ingenious if not wholly convincing.

In repairing the plant we are informed that the walls of the flume will be rebuilt substantially as before, save that the end wall will be of wood; the idea being that in case of another "water-hammer" occurring, the wood will give way instead of the masonry wall. It is estimated that in this way the total cost of repairing the damage done by the accident will not exceed $3,000. The figures given above for the hydrostatic pressure on the wall are sufficient comment.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Liability for Pollution of Stream Supplying Water to City.

The water supply of the city of New York is derived entirely from the valley of the Croton River. The watershed embraces an area of about 300 square miles in extent, and is drained by the three branches of the Croton, designated as the Eastern, Middle and Western. These branches unite in the upper part of Westchester Co., and the river runs on for several miles, until it receives the Muscoot River, which brings the water from Lake Mahopac, and then it flows into Croton Lake.

When it had been determined that the valley of the Croton should be utilized for the procurement of water for the municipality, the legislature passed a law authorizing the city to acquire title to land by right of eminent domain for the construction of a dam and reservoir at the southerly end of the shed, for the impounding of the water, and an aqueduct to convey the water to the city. Under that legislative authority, the dam, aqueduct, and reservoir were constructed, and the title to the land covered by water was acquired. The reservoir is known as Croton Lake. It is a narrow, crooked body of water, about four miles in length. The different branches of the Croton are augmented by smaller streams, and upon their banks and along the sides of the three branches are barnyards, privies, pigsties and other places where filth is collected and washed into the streams. These places for the collection and deposition of filth and putrefaction became so numerous and so extensive, and so polluted the water, as to cause alarm and anxiety among the inhabitants of the city. Scientific and medical skill united in declaring the danger to health and life very great and very imminent, and in answer to the demand for the adoption of some measure which would avert the peril by the removal of the cause, the legislature of the state, in March, 1883, passed an act entitled "An act to provide for the sanitary protection of the sources of the water supply of the city of New York." By Sec. 1 of that act it was made lawful for the Commissioner of Public Works of the city of New York to acquire or take in the manner thereinafter set forth, title to all real estate, and acquire or extinguish any interest therein of which the acquisition, taking or extinguishment may be necessary for the sanitary protection of all rivers and other water courses, lakes, ponds and reservoirs in the counties of Westchester, Putnam and Dutchess, so far as they were or thereafter might be used for the supply of water for the city of New York. The mode of acquiring titles and the extinguishment of interests is prescribed in the law from Sec. 2 to Sec. 26, inclusive, and they are the usual constitutional methods. By Sec. 27 of the act the Commissioner of Public Works is authorized to take such measures as may be necessary to preserve from pollution and defilement all the sources of the water supply in the three counties already mentioned, and to enter upon all lands near, adjacent or contiguous to any of the sources of water supply, and to abate and remove the cause of any such pollution or defilement. All damage and injuries to property occasioned by any act under that section were to be ascertained and paid in accordance with the provisions of the previous section of the act.

The plaintiff owns about 100 acres of land in the town of Carmel, and the Middle Branch of the Croton runs through the westerly portion of the farm from north to south. His barn and horse stables are on the east side of the stream, in close proximity to the bank, and his mansion is on the west side of the stream, a short distance from it. The drainage of his dwelling house, including that of the water closet, is let into the stream by a soil pipe, and is emptied there, and has been for many years. Upon the ascertainment of such facts, the Commissioner of Public Works directed the removal of the barnyard, stables, pigsties and outside privies upon the premises, and caused a cesspool to be constructed upon the land, and the soil pipe to be conducted into it, and not into the stream of water. Thereupon the owner commenced an action for the purpose of restraining the city and its officers from further interference with his property. The action is based upon the theory of the unconstitutionality of the act of 1883, already mentioned.

It is the legal right of every riparian proprietor to have a stream of water which passes through his land flow in its natural condition, with its channel unchanged and its purity unimpaired. Such a right was vested in, and pertained to, the city as the owner of the bed of Croton Lake, and the banks by which it was environed. That lake is, in fact, a running stream through which 100,000,000 gallons of water run daily in its onward progress to the city. The pollution of the water by the sewage from such house and the wash from the outbuildings was an invasion of the rights of the city, and also constituted a nuisance. Prior to the interference of the municipal authorities, the house sewage, including that of the water closet, was drained into the Middle Branch of the Croton River. These discharges from the human system are very poisonous, and the sewage is poisonous if taken into the stomach. It is a germ carrier, that is, it carries disease germs from the human system to the water; that these germs have the power of multiplying in the water, and a small number of them added to a large quantity of water will serve to infect the entire large body of water. It is therefore one of the most dangerous sources of pollution. The enormity of the offense will be more readily discerned if it be assumed that all the riparian proprietors within the Croton watershed have the same right to commit the same nuisance, and that the water is sent to the city freighted with the seeds of disease and death with which it would be thus contaminated. The disastrous results can hardly be conceived by the imagination. It is in the apprehension of such evils, and to preserve the public health, and to avert the danger to human life that the legislature has interfered for the sanitary protection of the sources of the water supply in the counties named. So far as property right can be acquired in water actually appropriated to practical use for domestic and other purposes, such right has been acquired in the waters of the Croton River by the city of New York. The purpose is a public one, and the power to exercise the right of eminent domain for its acquisition, and for the acquirement of the land and the extinguishment of rights necessary for its control and utilization, has been delegated to the mayor, aldermen and commonalty of the city of New York.

The great objection to the statute is that it undertakes to vest the title to the property taken or injured in the city before the final order for the confirmation of the report in the condemnation proceedings, but the objection is invalid. As law is settled in this state at the present day, it is within the competence of the legislature to authorize municipal corporations to take private property for public use without first making payment, provided a certain and adequate provision is made by which the owner can coerce compensation through the judicial tribunals or otherwise, without unreasonable delay. The enactment of the statute in question was a valid exercise of legislative power, and is not violative of the constitution of the state or of the United States.—(Digest from Kelly v. Mayor of city of New York.) 27 N. Y. S. Rep., 164.

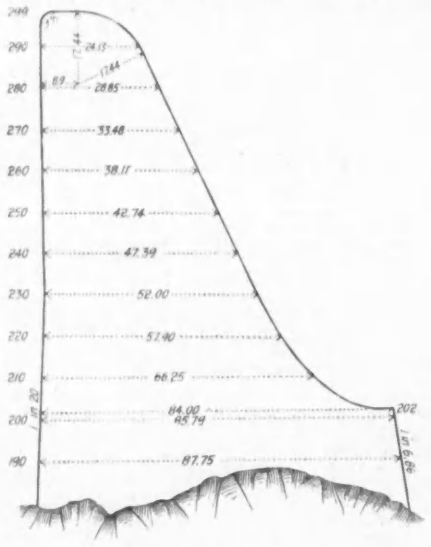
Liability of County for Defective Bridges.

Before the passage of the act of 1888 counties were not primarily liable for injuries received from defects in bridges where they had taken bond as required by law from the contractor who constructed the bridge. It appearing from the record that the county bridge in question was erected under a contract of letting to the lowest bidder on May 12, 1888, the act above mentioned, making counties primarily liable, did not apply to this case, that act not having been approved until Dec. 29, 1888. This act did not apply to bridges which had been let out and built before the passage thereof. The code makes it the legal duty of county authorities, when they let out a bridge to be built by the lowest bidder, to take from the contractors a bond and good security to keep the bridge in good repair for at least seven years. The bond taken in this case was for a term of only three years. Why the county authorities did not make the term seven years, as required by the code, is unexplained by the record. The injury to the plaintiff occurred before the expiration of the bond given, and therefore the contractor, and not the county, was primarily liable. If the injury had been received

after the expiration of the three years, it is quite likely that the county would have been liable, as in that event the county should be treated as taking no bond at all. But, inasmuch as the county took a bond for the term of three years, during which time the injury occurred, the bond may be taken as a sufficient guaranty contemplated by the code, so as to exempt the county from liability for damages sustained during that period, in consequence of the defective condition or want of repair of the bridge. The bond being such as is contemplated by the code and failing only as to the length of time for keeping the bridge in repair, and being a sufficient protection to persons injured prior to its expiration, the injured person should have sued the contractor and not the county.—Mappin v. Washington Co., Sup. Ct. of Ga., 17 S. E. Rep., 1009.

LA GRANGE DAM FOR TURLOCK AND MODESTO IRRIGATION DISTRICTS, CAL.

During the past year there was completed a large masonry dam across the Tuolumne River, two miles above the old mining town of La Grange, Cal. The work was begun in the fall of 1891, and the foundation was completed before the high water of the rainy season, in the following February. The next year's work carried the structure to about one-half its height and during 1893 the dam was completed.



It spans a rugged canyon, having a width of about 300 ft., its height above the lowest point of the foundation being 127½ ft. The dam has a thickness at the bottom of about 90 ft. and diminishes in thickness to a crest width of 11 ft., as shown by the accompanying cross-section. The section shown is a modification of several original designs, and was finally adopted to meet existing natural conditions, after consultation with a number of engineering experts.

The dam will have a depth of water of 8 ft. over the crest in ordinary seasons, while a depth of 16 ft. is not likely to be extraordinary at times. The dam curves upstream, having a 300-ft. radius, the ends abutting against solid ledges of rock that form the steep banks of the canyon.

The dam is built of large blocks of a blue trap rock, the blocks weighing from one to six tons, quarried in the immediate vicinity of the work.

The blocks were laid to break joints and are well bedded in concrete. The faces of the dam are of masonry laid in mortar. The dam contains 40,000 cu. yds. of material.

The work was done by the combined irrigation districts of Turlock and Modesto, under a contract made with R. W. Gorrill, the President of the Pacific Bridge Co., San Francisco.

An overhead tramway system, operating three cables, conveyed all the material from the banks of the river to its required location by the dam, and did the service so admirably that it became a very prominent factor in the economical conduct of the work.

The concrete was made in the proportions of 1 bbl. of cement, 2 of sand and 6 of broken stone, egg size, which made in place about 4-5 cu. yd. The appliances for breaking the stone and mixing the ingredients were of modern design and adequate to handle 150 batches per day.

The cement was furnished by the districts, and comprised the brands, K, B & S, J. B. White, Feuer Jossen and others. A tensile strength of 350 lbs. per sq. in., tested at the dam, was required.

The object of the dam is to raise water for irrigating the two large districts on the banks of the Tuolumne River, the one of the left bank, the Turlock, containing 170,000 acres, and the Modesto, on the right bank, 80,000 acres. The main canals will carry 2,200 cu. ft. per second, the designed depth in rock being 8 ft. for the former and 7 ft. for the latter district, while in earth the canals will carry 5 ft. of water with a cross-section having a bottom width of 70 ft. and a top width of 80 ft.

The work has been done under the immediate charge of Mr. Wm. McKay, who supervised the construction from the first conception to the final finish. The project of the near future is to provide the outlets to the canals and to lay out and build a distributing system.

We are indebted to Mr. McKay and to Mr. Otto von Geldern, Secretary of the Technical Society of the Pacific Coast, for the above information.

THE PAVEMENTS OF YOUNGSTOWN, O.*

By F. M. Lillie, City Engineer.

Youngstown has about seven miles of paved streets, including granite, Medina stone, asphalt and brick, the two latter comprising by far the larger part of the mileage. The first pavements were of both granite and asphalt, laid in 1882 on the principal streets of the city. The granite was laid on a gravel foundation, had its joints filled with heated gravel and coal tar, has cost nothing for repairs, and is in good shape to-day except where it has been dug up and relaid, but it is objectionable on account of its noise and roughness. The old asphalt is still in service, although much worn and requiring quite extensive repairs. During the past three years 1.7 miles of asphalt has been laid on residence streets. All asphalt has been laid by the Barber Asphalt Co., substantially after the Washington specifications, and with good results on grades as steep as 6%.

Granite has been the most expensive pavement. Good Medina stone costs about $3 per sq. yd. without foundation, and asphalt at present, $2.60, including concrete base.

The demand for a cheaper pavement led to the use of brick, which were first laid in 1887. At that time first-class paving brick were scarce and their good qualities not well known. In addition furnace slag was used as a foundation, which is liable to uneven settlement. All this tended to throw discredit on brick pavements, but in 1889 a good quality of brick was laid on a gravel foundation, which after four years' wear is nearly as good as when new. Lately a concrete base has been used with satisfactory results.

Our present practice in laying brick is to cut the subgrade down 9 ins. below the finished surface and shape it parallel to the latter by means of a form reaching from street railway track to the curb. The earth is then rolled with a 10-ton steam roller until thoroughly compacted, after which is put down a 4-in. rammed concrete base, consisting of 1 part Saylor's Portland cement, 3 parts sand and 7 parts broken limestone. Upon this 1 in. of sand is placed and brought to surface by the form, as described above. Hard burned, sound and tough brick, with less than 2% absorption in twelve hours, are then laid on the sand cushion and rolled until they will settle no more, the roller weighing 1¼ tons per lin. ft. of roller face.

Coal tar or asphaltic cement joints having proved objectionable on some streets on account of slipperiness, and a street laid last summer being on a considerable grade, it was decided to use cement filling in place of tar. A thin mortar of equal parts of German Portland cement and fine sand was used with good results, so far as has been ascertained to date.

The track brick inside the rail were beveled on end 2½ ins., horizontally to 1 vertically. This pavement cost $1.53 per sq. yd., including foundations, or about $1 less than asphalt. It is second only to asphalt in smoothness and cleanliness, while judging from the best examples of brick pavements we believe it superior to asphalt in durability.

*Abstracted from a paper read before the Ohio Society of Surveyors and Civil Engineers, at its meeting at Cleveland, Jan. 16 to 19, 1894.

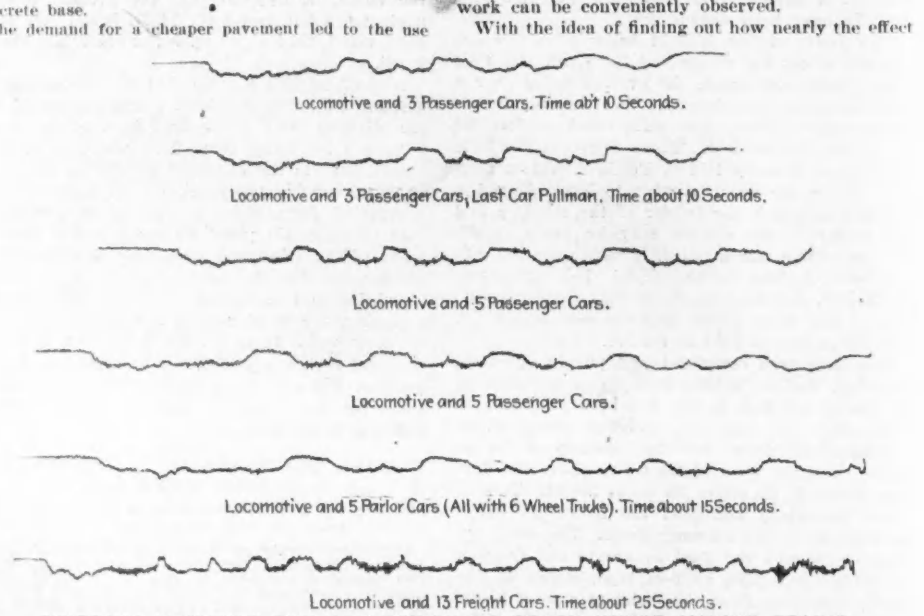
DEFLECTIONS OF TRACK UNDER MOVING TRAINS.

By Edwin H. Messiter.

The writer has recently had an opportunity of making some observations upon the effect of locomotive and train concentrations in the moving load on a railway structure which may be of interest to some of the readers of Engineering News.

The traffic of the Pennsylvania R. R. is now carried through the city of Elizabeth, N. J., for the most part, on a heavy two-track timber trestle, while for the other two tracks permanent embankments and masonry arches are being built. At one end of the skew bridge which crosses the Central R. R. of New Jersey, half of the bridge rests on a temporary timber abutment, and the other half on the completed masonry abutment. From this masonry abutment the action of passing trains upon the relatively elastic and compressible timberwork can be conveniently observed.

With the idea of finding out how nearly the effect of a moving train approaches that of a series of isolated wheel concentrations, the writer made a simple apparatus for recording the deflections of a crosstie. Sheets of paper were tacked to a board which was free to slide horizontally in a frame that rested firmly on the masonry abutment. To the end of one of the crossties a pencil was attached in such a way that its point could be pressed against the paper by a spring, but so as to allow no motion of the pencil horizontally or vertically with respect to the tie. The tie selected was at the end of the skew span and rested almost entirely on the timberwork. The board carrying the sheet of paper was moved slowly by hand while a train was passing. It was impossible to move it in this way at a per-


Locomotive and 3 Passenger Cars. Time abt 10 Seconds.
Locomotive and 3 Passenger Cars, Last Car Pullman. Time about 10 Seconds.
Locomotive and 5 Passenger Cars.
Locomotive and 5 Passenger Cars.
Locomotive and 5 Parlor Cars (All with 6 Wheel Trucks). Time about 15 Seconds.
Locomotive and 13 Freight Cars. Time about 25 Seconds.

DIAGRAMS SHOWING THE DEFLECTION OF TRACK UNDER MOVING TRAINS.

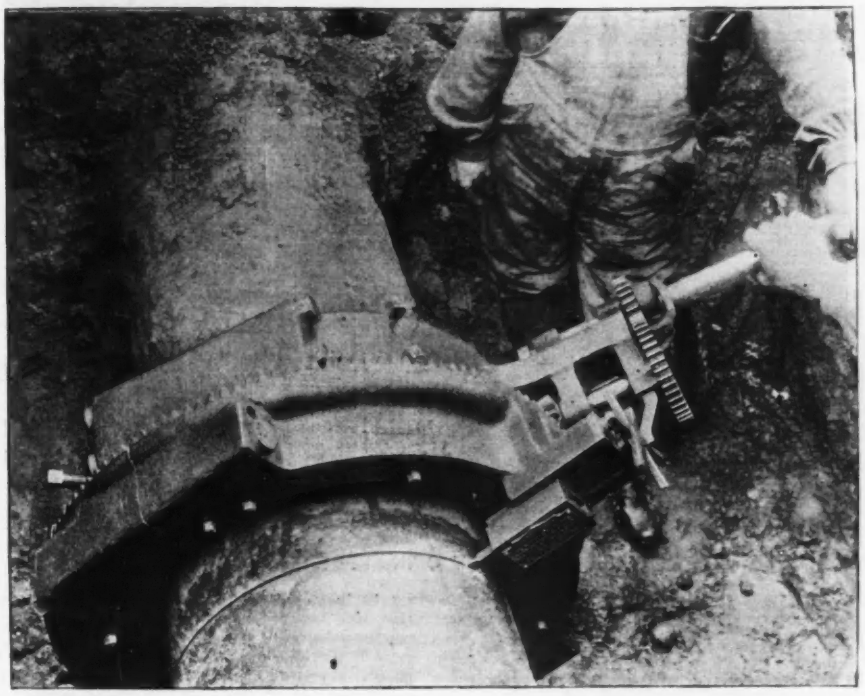
fectly constant rate, but it moved smoothly and without jerks.

The accompanying diagrams show the lines traced by the pencil under the action of all the trains which passed over the westbound track between 3:30 and 5:10 p. m. on Feb. 10. All the locomotives which passed were of the standard American passenger type. The diagrams make it appear that the engine and tender in every case acted as a continuous load, showing in most cases noticeable depressions under the drivers. It also appears that the pair of trucks formed by the rear truck of the car and the forward truck of the next acted almost as a continuous load, the deflection not returning to zero between the trucks as it did under the middles of the cars.

The number of seconds which elapsed while the train was passing was noted in some cases to give a rough idea of the velocity. None of the trains were running at a high speed, and some were slowing up in order to stop at the station.

CUTTING A 20-IN. WATER MAIN IN PLACE.

The difficulties, delays and waste of material incident to the old methods of cutting cast iron pipe while in position in a trench are well known to a large class of the readers of this journal. In our issue of Aug. 31, 1893, we described and illustrated



VIEW OF PIPE-CUTTING MACHINE IN PLACE, SHOWING KNIFE AND FEED.

a pipe-cutting machine and present herewith a view of the same machine in position while cutting a 20-in. main for the Hackensack Water Co., of Hoboken, N. J. The main in question is one of the force mains at the company's distributing reservoir and was cut for the insertion of a valve where the pipe passes through the reservoir embankment. The illustration is a direct reproduction from a photograph taken with the camera on the edge of the trench pointing downward at a sharp angle. It shows the second cut nearly completed. When the cutting is completed for a gate and the gate is joined on one side to the long piece cut out, the gate and section of pipe are lowered into place, the free end of the gate is joined to one cut end of pipe and a sleeve previously put in position is slipped over the unclosed pipe and properly calked.

The cut shown under way in the figure was made in 23 minutes after setting the machine, four men being employed. It is reported that the whole work of making the three cuts and setting the gate was completed in about 3½ hours, with the two shifts of two men at the crank. Mr. D. W. French, Deputy Superintendent of the Hackensack Water Co., of Hoboken, N. J., inventor of the machine, has prepared a table showing the estimated saving effected by using this machine in a variety of connections, which may be had by addressing Mr. Benj. C. Smith, selling agent, 275 Pearl St., New York. The pipe is made in eight sizes to cut from 3 to 48-in. cast iron and 2½-in. wrought iron pipe, one size of machine, for instance, being capable of easy adjustment to cut 10, 12, 14 and 16-in. pipe. The machine has been furnished for use in connection with a number of gas and water-works in this and foreign countries.

THE PROSPECTS FOR A NORTH RIVER BRIDGE.

So much interest is felt by engineers generally in the construction of the proposed great bridge across the North River at New York city that the following recent interview on the topic with Mr. Chauncey M. Depew, President of the New York Central & Hudson River R. R., will doubtless be read with interest. After stating that "inquiry as to the sources of financial support expected to be forthcoming for the advancement of the enterprise fails to elicit anything except indifference," a "Tribune" reporter quotes Mr. Depew as follows:

The question of a bridge over the Hudson River from some point in New Jersey to some point in New York city has been the subject of legislation and speculative literature for ten years past. The New York Legislature has legislated on the subject in favor of a bridge, and, it seems, is now asked to grant a charter for another. Congress also passed a bill, which was vetoed by the President. The New York Central is generally used by the promoters as the bugaboo to scare the bill through, the argument being that, as the New York Central is the only road which runs into the city of New York, it views with an ever-abiding and constantly increasing fear the possible entrance of the lines terminating at Jersey City over a bridge into its favorite terminal territory. It is argued that it would be greatly for the interest of the public to defeat this selfish policy and have all roads terminate within the city limits. As a matter of fact, the New York Central has never interposed any objections, directly or indirectly, to the bridge bills, either at Albany or at Washington. We have a divided interest, because our West Shore line, which terminates at Weehawken, would share in the benefits of the bridge, if the bridge had any benefits to divide.

But we have always believed the scheme to be impracticable; not that, from an engineering standpoint, the bridge could not be constructed, but because the cost of the bridge, the approaches and the land necessary for terminal yards and stations would be so great that the interest upon the capitalization, the taxes and maintenance would make a greater annual cost than the roads concentrating at Jersey City could afford to pay for the use of the bridge.

The bridge promoters estimate between 80,000,000 and 100,000,000 passengers, and from 130,000,000 to 140,000,000 tons of freight annually across the Hudson between New York city and the different points on the Jersey shore. These figures are larger than the actual traffic between New York and Jersey City. I have not at hand the figures showing the amount of business done by the other lines, but will take the West Shore figures as a basis for forming my opinion as to the total number of passengers and tons of freight. For the fiscal year ending June 30, 1893, the number of passengers passing between New York and New Jersey over the West Shore ferries was 749,028. The number of tons of freight was 1,480,711. The roads terminating at Jersey City whose traffic could be considered in this connection would be the Pennsylvania, the Erie, the Lackawanna, the New Jersey Central and the roads coming in over their tracks. It is hardly possible that their figures could be so tremendously in excess of those of the West Shore as to make the estimated amount of freight or number of passengers. Each of these lines has very extensive and expensive terminals on the Jersey shore, and also piers, warehouses and ferry slips on the New York side. They would not use the bridge unless it would be cheaper to them to do so than to use their present facilities.

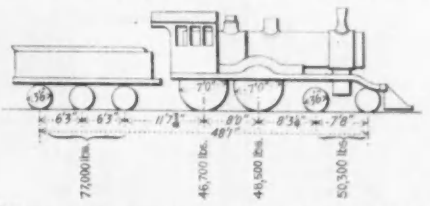
Each of these roads has uptown and downtown ferries. Could they run their cars up along the Jersey shore to this bridge, across it, and down on the New York side to the proposed depot at Seventieth St., and distribute the passengers by elevated roads to their destination downtown as quickly as they can take them across by ferryboat to their present ferry landings? They could not increase their commutation rates, and the commuters form the bulk of the travel; therefore, the rate per passenger over the bridge, together with the fare down town, would have to be less than it costs now, say, to carry them by the big ferryboats from the Pennsylvania depot at Jersey City to the Cortlandt street ferry.

As to freight, this is delivered by floats at an astonishingly cheap cost per ton from the Jersey City terminals of all the lines to their piers along the North River front and to a dozen points around the harbor, as, for instance, to the sugar companies' wharves at Williamsburg. Delivery from the freight terminals in New York city to the bridge, if it is assumed that it shall be done by trucks, would be prohibitory, and no other process is at present in sight. But the great question with a railroad would be, could it deliver its freight to its consignees and warehouses as cheaply, after paying the bridge toll, as it can now by its floats?

About every month or two there comes a statement that the Pennsylvania road is deeply interested in some scheme of this kind, or that the Lackawanna or New Jersey Central are determined to build a bridge themselves. The managers of all these roads have repeatedly said to me within the last year that they did not think it would be possible for them, on any toll which the bridge could afford to charge, to transfer their business from their present termini, ferries and floats to the bridge; nor did they see that it would be of any use or benefit to them if built.

COMPOUND LOCOMOTIVE; PENNSYLVANIA R. R.

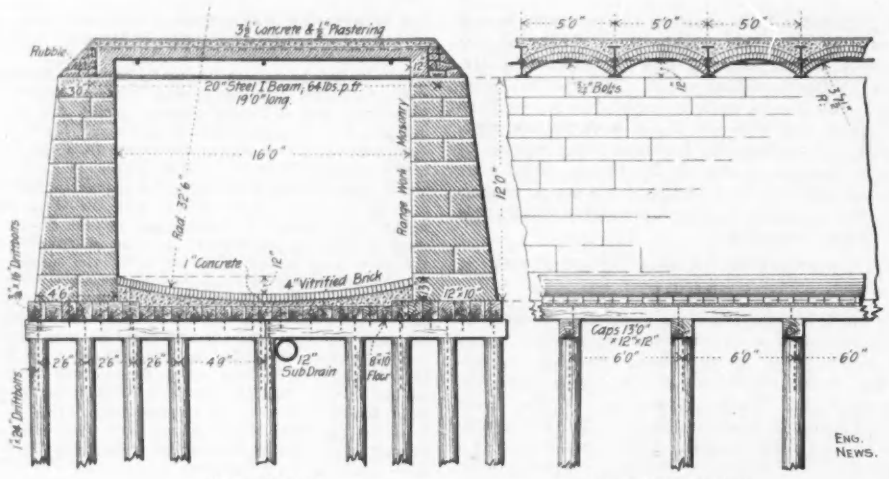
The two-cylinder compound express engine built at the Altoona shops of the Pennsylvania R. R. was briefly described in our issue of Dec. 7, 1893, and in answer to a correspondent we give herewith a diagram of the wheel base and wheel loads of this engine. The starting gear is of the Lind-



Compound Express Locomotive; Pennsylvania R.R.

ner system, largely used in Europe, and one of the peculiar features of the engine is the use of a six-wheel tender. The leading dimensions are as follows:

Driving wheels, diam.	7 ft.	0	ins.
Truck and tender wheels, diam.	3 "	6	"
Wheelbase, driving	8 "	0	"
" engine	23 "	11¼	"
" tender	12 "	6	"
Weight on drivers (48,500 and 46,700 lbs.)		95,200	lbs.
" of engine		145,500	"
" of tender		77,000	"
Cylinders	19½ × 28 ins. and 31 × 28		ins.
Boiler, Belpaire, diam.	5 ft.	0	ins.
Boiler pressure		200	lbs.



Cross Section. Longitudinal Section.

FIG. 1. SECTION OF CANAL ST. SEWER, ST. PAUL MINN.

CANAL STREET SEWER, ST. PAUL, MINN.

By Geo. L. Wilson, M. Am. Soc. C. E.,
City Engineer.

During the past season a large sewer was built in St. Paul under charge of the writer which had some novel features that may be of interest. The construction was through made ground, with a soft bottom requiring pile and timber foundation. The length of piles below cut-off varied from 15 to 28 ft., at which point a hard gravel bed is struck. The accompanying sections, Fig. 1, show the method of construction and dimension. Fig. 2 is a view of the sewer under construction, and Fig. 3 an interior view after completion. A novelty for sewer construction is on the roof, where, on account of limited head room, the street grade giving only from 3 to 5 ft. of covering, a flat top was desirable. It was also found that the steel beams and arches were the most economical. The side walls, which would be light for deeper cuttings, were sufficient in this case, when braced inside with temporary bracing until the masonry was set.

The 16-ft. section forms the continuation of a 10-ft. and a 12-ft. sewer, the junction of which is shown by the views, Figs. 2 and 3. Both of these branch sewers pass through ground where the right of construction was condemned and have a similar roof to that of the 16-ft. section, the top of the roof being intended to serve as the floor of wholesale warehouses to be built over the sewers.

So far as the writer is aware, this is the first use of steel beams for a sewer roof. The beams were coated by dipping in coal tar varnish; and when in place on the work, before the arches were put up, they were given a brush coat of cement. The length of the 16-ft. section, when completed, will be about 1,700 ft., and of the 10 and 12-ft. sections together about the same.

The 12-in. subdrain, shown in Fig. 1, was by no means the least important factor in the work, as during some of the time it flowed with a clear stream 10 ins. deep.

The prices were as follows: Excavation, including refilling, pumping and timbering of trench, 34 cts. per cu. yd.; piling, 17½ cts. per lin. ft.; timber, $19.50 per M.; side walls, $4.75 per cu. yd.; concrete, $5 per cu. yd.; brickwork on arches, $12.75 per M.; vitrified brick paving in invert, $19 per M.; steel I-beams, 2½ cts.; cast iron, 2 cts.; and wrought iron, 3 cts. per lb. At these prices the cost of the 16-ft. section was $60 per lin. ft.

FIG. 3. INTERIOR VIEW OF JUNCTION OF 10 AND 12-FT. SEWERS, ST. PAUL, MINN.

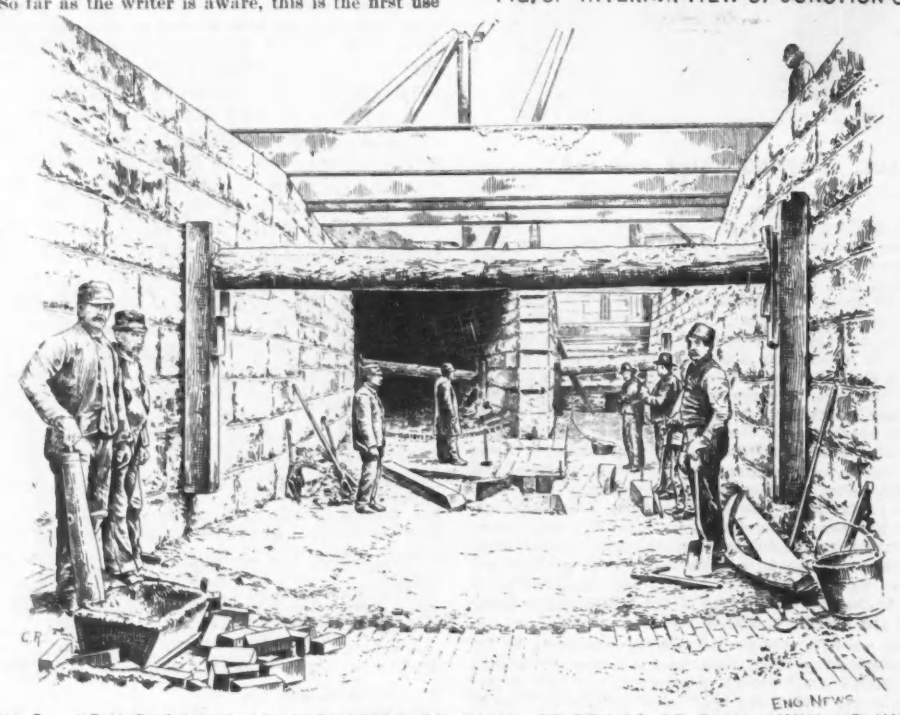


FIG. 2. VIEW SHOWING CONSTRUCTION OF CANAL ST. SEWER, ST. PAUL, MINN., AT JUNCTION OF 12 AND 13-FT. SEWERS.

An evasion of the spirit of the law against "salary grabbing" has just taken place at New Haven, Conn., which may be recited without comment. Under the Connecticut statute, the salary of a city official cannot be increased to take effect while he is in office. The city engineer was receiving $2,100 and the superintendent of sewers $1,800, and it was desired to increase both salaries to $2,500. Both officers therefore tendered their resignation at a recent meeting of the board of public works. The resignations were unanimously accepted and a few minutes later both were reappointed at the increased salaries named.

Eight 36-ton girders have been made by the Edge Moor Bridge Works for use in the new Philadelphia Bourse. These girders were hauled from the Pennsylvania R. R. yards, in West Philadelphia, on a heavy truck with 10-in. tires. The fifth girder was hauled down Market St. on March 14 and crushed stone paving blocks, crossing stones, manhole covers, etc., on its path, and left deep furrows in the street at places. The city, the Philadelphia Traction Co. and the Bell Telephone Co. have entered claims against the builder of the Bourse for the damage done.

The natural laws of mechanics and the application of force employed in stage tricks were publicly explained recently at a place of amusement in Chicago, by Mr. T. H. Brigg, M. E., who had accepted the advertised challenge of the manager of one of the so-called "magnetic women" to explain and perform the various performances, which consisted of lifting persons in chairs and other feats. These were claimed to be performed in some mysterious manner without the exertion of muscular force, but Professor Brigg showed this of course to be absolutely false, and himself performed the same feats, explaining the theory in each case. Mr. Brigg has made a special study of the theory of the application of force, particularly in regard to the proper methods of harnessing horses so as to allow them to exert their full power according to the load hauled and the grade of the road. A paper on this subject was

presented by him before the Mechanical Engineering Section of the Engineering Congress in Chicago last summer.

The proposed Philadelphia-Harrisburg trolley road is being fought by the Pennsylvania R. R. Co., which claims that when the old railway was sold by the state the buyer bought a monopoly, and that the state is estopped from granting a charter to build a parallel and competing line. This only applies to the part of the long-distance electric road parallel to what was the old state railway. On the other hand, it is stated that the projected Philadelphia-New York trolley line is meeting with no opposition, because officers of both the Pennsylvania and Reading railways are interested in it and will presumedly control it. One rumor has it that the projectors of the Harrisburg line expect that they can make their project sufficiently prominent or obnoxious to induce the Pennsylvania R. R. to buy them out, and then stop.

CONSTRUCTION NEWS.

(Readers are invited to contribute items concerning new construction of interest to engineers or contractors for insertion in these columns. Those using these pages for information are informed that announcements of calls for proposals are inserted but once, and are not repeated from week to week.)

RAILWAYS.

East of Chicago—Existing Roads.

CANADIAN PACIFIC.—It is reported that an extension will be built to Amherstburg, Ont., the line to be in operation in October.

CHICAGO & SOUTHEASTERN.—The construction of an extension of this road from Anderson, Ind., to Muncie, 15 miles, has been commenced and it is expected that the line will be completed in July. Ch. Engr., J. W. Moore, Anderson, Ind.

CLEVELAND, LORAIN & WHEELING.—The trestlework for the new line between Mallet Creek and Cleveland has been awarded to T. A. Kearns, Chicago. Ch. Engr., Wm. C. Jewett, Cleveland, O.

LOTLINIERE & MEGANTIC.—Jack T. Morkill, Engr. and Supt., Lyster Station, Que., writes us that this railway is chartered to extend from St. Jean des Chaillons, on the St. Lawrence River, to Glen Lloyd, connecting with the Grand Trunk Ry. at Lyster Station. Eleven miles were constructed in 1893 and D. G. Loomis & Sons, Sherbrooke, Que., have been awarded a contract for 10 to 14 miles to be built this year.

Projects and Surveys.

CAPE MAY.—Incorporated at Cape May, N. J.; capital stock, $400,000; Pres., Logan M. Bullett, Philadelphia; Secy., Thos. H. Willson; J. E. Taylor, J. M. E. Hildreth, Dr. Jas. McCray and others, Cape May, N. J.

CLEARFIELD, CONEMAUGH & WESTERN.—The incorporation of the Clearfield & Conemaugh R. R. Co. was noted last week. The "Railroad Gazette" gives the following additional information: The company has been consolidated with the Clearfield Creek road, under the above name. One of the terminal points is Johnstown, Pa., and the route is thence northward through Cambria and Clearfield counties, a distance of about 75 miles to the mouth of Little Clearfield Creek, where it will connect with the Beech Creek R. R., and establish communication by means of the Beech Creek and its connections with New York and Philadelphia. It will also connect either by the Beech Creek road or by a branch with the Clearfield & Mahoning R. R. with the Buffalo, Rochester & Pittsburg R. R., thus giving communication with Rochester, Buffalo, and points upon the lakes. At Johnstown it will connect with the Baltimore & Ohio and other roads, and thus reach Pittsburg and the West. Work is now being done upon that portion of the line which was formerly owned and located by the Clearfield Creek R. R., and the remainder of the line will be located as speedily as possible, the chief engineer and his assistants now being ready to begin the survey. The chief engineer is Samuel Brugger, and his present post-office address is Fleming, Center county, Pa.

FORT WAYNE & EASTERN.—Incorporated in Indiana to build a railway from Baldwin to Ft. Wayne, 20 miles; capital stock, $50,000; F. B. Lord, S. P. Savage, L. H. Beers, New York.

MICHIGAN.—Geo. T. Hall, Secy. Watervale Mfg. Co., is reported as stating that a company is being organized at Watervale to construct a railway east from that city about 20 miles to connect with the Toledo & Ann Arbor and Manistee & Northeastern roads, and that six miles of the route has been surveyed and a part of the right of way secured.

PHILIPSBURG, EBENSBURY & JOHNSTOWN.—Incorporated in Pennsylvania to build a railway from Janesville, Clearfield county, to Johnstown, Cambria county, with branches to adjacent coal mines, 48 miles; capital stock, $1,200,000; Pres., Samuel P. Langdon, Philadelphia.

PITTSBURG & EASTERN.—Incorporated in Pennsylvania to build a railway from Crab Tree, Westmoreland county, to Whites Station, Indiana county; capital stock, $250,000; Pres., S. H. Hicks, Philadelphia.

Southern—Existing Roads.

GEORGIA.—A press report from Savannah, Ga., states as follows: There are being built in Tatnall county two railways for the transportation of lumber and crossties, in which that section abounds. The first is being built by the Parrot Lumber Co., of Atlanta, which is using the Chattahoochee Brick Co.'s convicts for the work. It is to run from Hagans, on the Savannah & Western, to Glynville, a distance of 16 miles. About five miles of it have already been built and an engine has been purchased. It traverses a rich lumber section and will have two large sawmills along the line. It is already shipping several carloads of lumber a day. ——Another short line, 12 miles in length, is being built from Manasas, also on the Savannah & Western, in Tatnall county. Manasas is about five miles west of Hagans. This road is being built by a man named Cummings, and is a lumber road also. The grading of the latter however has just been commenced.

JACKSONVILLE, ST. AUGUSTINE & INDIAN RIVER.—The extension of this railway to West Palm Beach, Fla., was completed March 19. The extension is 190 miles long and makes the main line of the railway 300 miles long from Jacksonville to West Palm Beach on Lake Worth.

WEST VIRGINIA.—Jaeger Bros., Roderfield, W. Va., are reported as building a logging road two miles long to connect timber lands with the Norfolk & Western.

Projects and Surveys.

PLANT CITY, OKEECHOBEE & LAKE WORTH.—Incorporated at Plant City, Fla., to build a railway from Plant City to Lake Worth, 125 miles. It is claimed that the construction of the road will soon be commenced. Pres., Maj. T. B. Mills; Vice-Pres., Col. C. W. Stevens; Gen. Man., Capt. G. B. Baker.

Northwest—Existing Roads.

ILLINOIS CENTRAL.—Press reports from Yankton, S. Dak., state that surveyors of this company are at work on a line from Le Mars, Ia., to that city, 90 miles.

Projects and Surveys.

CHICAGO, SUPERIOR & PACIFIC.—Incorporated in Illinois to build a railway from Chicago by way of Milwaukee to Superior, Wis.; capital stock, $4,000,000. The route is that surveyed for the Chicago & Northern Pacific Air line Ry. in 1872 and of which about 185 miles have been graded and bridged. The project includes 530 miles of railway in Wisconsin, and about half of the right of way for the whole road is said to be in possession of the new company. Wm. R. Chadsey, whose father secured possession of the old Wisconsin Central in 1863, is said to be at the head of the new enterprise, which is reported as in the interest of the Canadian Pacific. The directors are: Robert E. L. White (Pres.), W. H. Schnebel, Robt. H. Browne, Thos. F. C. Fletcher, Geo. W. White, P. M. Snowden and J. M. White, Washington, D. C.; Wm. R. Chadsey, J. C. Barnes and Vernon Seaman, New York; Geo. Rawlins, Richmond Hill, N. Y.; Lorenz Smith, Brooklyn, and Oliver Deming, Wethersfield, Conn.

Southwest—Existing Roads.

GREENFIELD & NORTHERN.—Maj. Harvey W. Salmon, Clinton, Mo., is reported as stating that this company will build 100 miles of railway this year.

PINE BLUFF & EASTERN.—It is stated that arrangements have been completed for building a five-mile extension of this railway.

Projects and Surveys.

ARCADIA LUMBER CO.—The Arcadia Lumber Co., Arcadia, La., is reported as about to build an eight-mile logging railway.

GULF & INTERSTATE.—C. J. Jones, Ch. of Constn, as noted March 1, is reported as stating that work would be commenced at Port Bolivar, Tex., last week with four powerful grading machines, and three corps of engineers and 20 or 25 construction gangs would be put at work at once and the grading pushed at the rate of two miles a day.

SAN ANTONIO & GULF SHORE.—It is reported that the contract for constructing this railway, or a portion of it, will be awarded within 10 days. Gen. Man., Wm. Davis, San Antonio, Tex.

Rocky Mt. and Pacific—Projects and Surveys.

SUMMIT MINERAL.—Arthur G. Lombard, Helena, Mont., has surveyed a route for this proposed railway in the Rimini mining district. The line would be about 20 miles long and narrow gage.

WYOMING.—A company is being organized at Buffalo, Wyo., according to reports, for building a railway from that city to connect with the Burlington & Missouri River at Clearmont, a distance of 30 miles.

STREET AND ELECTRIC RAILWAYS.

CHELMSFORD, MASS.—The selectmen are to meet March 30 to locate the route for a proposed electric railway.

WESTFIELD, MASS.—The Highland St. Ry. Co. will receive bids until April 14 for furnishing all material except rails and ties, and building 2¼ miles of street railway. R. D. Gillett, Clk.——Press reports state that the company will experiment with compressed air as a motive power.

WORCESTER, MASS.—Surveys have been made for extending the Worcester & Millbury St. Ry. from Millbury through Wilkinsonville, Saundersville, Fisherville, Farnumsville and Rockdale to Northbridge, leaving the main line at Millbury at Elm and Main Sts. and passing through Elm, Canal and Providence Sts. The construction will be commenced as soon as authority has been obtained to issue bonds.

ESSEX, CONN.—Efforts are being made at this place and Ivoryton to organize a company to construct an electric railway between the two places.

HARTFORD, CONN.—The street railway companies have been granted authority to adopt the overhead trolley system. The question has been before the council for about eight months.

BROOKLYN, N. Y.—The Coney Island, Fort Hamilton & Brooklyn R. R. Co. has been incorporated to build a road five miles in length; capital stock, $500,000; directors, P. K. Flynn, John Mullin, John Murphy, Willis Brower, Alex. Walker, P. F. Lynan, Michael Murphy, Brooklyn; Richard Bergen, Paterson, N. J.; and J. K. O. Sherwood, Glen Head.

CHESTER, PA.—A press report to the Philadelphia "Press" states as follows: All the electric railways centering in this city have been united under one company, and the new system will have a total mileage of nearly 40 miles of railway. The new corporation will be known as the Chester Traction Co., and it is understood that the Philadelphia Traction Co. is interested in the deal. Col. Samuel A. Dyer, who has been the active spirit in the Union Ry., will control the new concern. The lines absorbed by the Chester Traction Co. are the Chester St. Ry., which owns most of the original franchises in this city; the Union Ry., which has a lease on the lines of the Chester St. Ry., and controls lines to Upland, Eddystone and Marcus Hook; the Chester & Media Electric Ry., which has a line from this city to Media, six miles, and valuable street franchises in Media borough, and the Chester, Darby & Philadelphia Ry., which owns and operates a line from this city to Darby, nine miles, where it connects with its Darby extension of the Philadelphia Traction Co.'s lines, upon which the trolley system is now being introduced. The new company will own the large central power house in this city, which supplies the current for all the above lines. The capital stock is $500,000, and the incorporators are Samuel A. Dyer, William Wilson, Charles F. Wagner, Jr., Eugene Harvey, George F. Potteiger.

WISSAHICKON, PA.—The Wissahickon Electric Ry. Co. has awarded the contract for constructing an extension of 8,400 ft. long to Jones & Wallace and the work will be commenced at an early date.

BLACKSBURG, VA.—L. S. Randolph, Mech. Engr., writes us that an electric railway is being built connecting this place, the Virginia Agricultural and Mechanical College and Christiansburg, Va., with the Norfolk & Western R. R., length nine miles. For particulars address John A. Harman, Blacksburg, Va.

BLUEFIELD, W. VA.—The Bluefield Electric Ry. Co. has been incorporated to build an electric railway, about 20 miles in length, for the purpose of connecting six towns in the Bluefield coal region. The railway will carry both freight and passengers. Capital stock, $20,000; incorporators, John Wirgman, Wm. H. Triol, J. Walter White, F. W. Halsey and R. J. Ringwell, all of Philadelphia.

LIMA, O.—Bids are asked until April 9 for constructing and operating the College St. Ry. route. J. B. Douglass, Cy. Clk.

HOUSTON, TEX.—The Houston & Suburban St. Ry. Co. has been incorporated by A. Christeson, W. A. Wilson, Jr., and E. W. Cave; capital stock, $100,000.

KINGSTON, ONT.—The Kingston, Portsmouth & Cataraqui Electric St. Ry. Co. has been granted a 60-year franchise for an electric railway through Portsmouth, a village two miles from this city.

HIGHWAYS.

NEW YORK.—The town board of Tarrytown has voted to spend $16,000 for road improvements, according to reports.——Scarsdale, Westchester county, will vote on appropriating $20,000 for macadamizing roads.

ALABAMA.—The commissioners of Colbert county have sold $100,000 of bonds for building macadamized roads. It is thought that 50 miles of roads can be improved with this.

OHIO.—Bids are asked until April 27 for the sale of $10,000 of bonds for improving Mifflin township cemetery road. H. J. Caren, Co. Aud., Columbus, Franklin county.

BRIDGES AND TUNNELS.

NEW YORK, N. Y.—The Interstate Hudson River Bridge Co. has petitioned the state legislature for authority to construct a bridge over the Hudson River between 170th and 185th Sts. The bill provides for two spans which are to be 160 ft. high. Capital stock, $1,000,000. Incorporators, John G. Hyatt, Chas. H. Wosman and Geo. W. McWaters.

[illegible] PA.—Congress has passed the bill authorizing the Glenwood Bridge Co. to construct a bridge across the Monongahela River at this place.

PHILADELPHIA, PA.—Bids are asked until April 2 for constructing a bridge on Girard Ave. over Pennsylvania Ave. J. H. Windrim, Dir. Pub. Wks.

PITTSBURG, PA.—The Kensington Rapid Transit Bridge Co. has been chartered to erect a bridge over the Allegheny River from Ferry St., Creighton, to New Kensington; capital stock, $20,000; directors, E. Moore, B. F. Rafferty, P. Cappeau, C. C. Hussey and Gustave Kaufman.

WASHINGTON, D. C.—Efforts are being made by residents on the south shore of the Eastern Branch to secure an additional bridge at the foot of South Capital St.

CINCINNATI, O.—In 1891 the board of administration was authorized to construct a viaduct on Gilbert Ave. at a cost not to exceed $500,000, and it is reported probable that the work will soon be commenced.

CHICAGO, ILL.—The Gagnier-Griffin Suspended Ry. Bridge Co. has been incorporated; capital stock, $1,000,000; incorporators, Geo. Mason, G. H. Griffin, J. O. Baird, J. S. Chadwick, B. J. Gagnier and J. S. Wilkin. ——Bids will be received at the U. S. Engineer Office until May 1 for the construction of a railway and a highway swing bridge at Milan, Ill., as stated in our advertising columns. Capt. W. L. Marshall, U. S. A.

JEFFERSON CITY, MO.—Press reports state that Alex. Weber, Engr., Jefferson City Bridge Co., has finished taking soundings for the proposed bridge across the Missouri River between this city and Cedar City. Soundings were taken at eight different places, and solid rock found at depths in the middle of the river from 44 ft. to 72 ft. On this side of the river rock bottom was found within a few feet. The company is much pleased with the result of the work, as it was anticipated that it would be necessary to go much deeper. It is likely that the bridge will be constructed from the foot of Madison St.

LEXINGTON, MO.—Geo. A. Fain, Jr., Engr., writes us that the citizens are talking of building a double-roadway wagon bridge or a combination railway and wagon bridge across the Missouri River at this place. The bridge would be about 1,800 ft. long. Leo. Keller, Secy. Bd. Trade.

COLUMBIA, TEX.—R. C. Duff writes us that the contract for the proposed bridge, recentiy noted, has been awarded to the Chicago Bridge & Iron Co., at $24,757, the other bidders being: Jno. C. Underwood, Penn Bridge Co., Milwaukee Bridge Co., Missouri Valley Co., Youngstown Bridge Co., Groton Bridge Co. and Columbus Bridge Co.

EVERETT, WASH.—The Great Northern Ry. Co. is reported as about to ask for bids for constructing a tunnel 1,400 ft. long under this city, on the Pacific coast.

TACOMA, WASH.—The bids received Feb. 19 for the proposed Eleventh St. bridge were published March 1. The bids opened March 12, the third opening, were as follows: Mission Bridge & Iron Wks., $89,445; King Bridge Co., $85,595; Hoffman & Bates, $91,000; Groton Bridge & Mfg. Co., $88,000; Puget Sound Dry Dock Co., $102,000; Bullen Bridge Co., $85,985; H. Krust, $88,600; Penn Bridge Co., $95,500.

WINNIPEG, MAN.—The council has voted to ask for bids for the iron superstructure of the proposed bridge at Maryland St.; estimated cost, $22,000.

CASSELMAN, ONT.—Press reports state that the new iron bridge over the Nation River at this place has been swept away by the floods. Only one span of three re-

mains, and the piers are badly smashed by ice. Ex-Alderman Rousseau, Montreal, builder of the bridge, is reported as stating that the destruction of the bridge was due to the piers having been too low. He had advised 14-ft. piers, but the Casselman council had considered 12 ft. sufficient, and the bridge had been built accordingly.

WATER-WORKS.

DAMARISCOTTA, ME.—The selectmen have been authorized to contract with any water company for ten hydrants at an annual rental of $100 each, according to reports.

MECHANIC FALLS, ME.—The "Ledger" advocates the construction of a complete system.

NEW CASTLE, ME.—A committee has been appointed to investigate the question of works.

KEENE, N. H.—The commissioners have asked for $7,000 for relaying cement and other pipe.

MEREDITH, N. H.—The contract for works has been awarded to E. E. Eglee, New York, at $32,000; gravity supply from Wadleigh Brook. Consult. Engr., S. M. Gray, Providence.

BARTON LANDING, VT.—The village has voted to put in works for fire protection, the present supply being only for domestic purposes; estimated cost, $8,000. J. H. Brown, Chn.

ST. JOHNSBURY, VT.—At a special village meeting, March 19, it was voted not to sell tre present works to the St. Johnsbury Aqueduct Co. The aqueduct company is expected to begin at once to enlarge its plant, as noted March 1, and it is reported probable that another village meeting will soon be held to consider the question of an increased supply.

BRADFORD, MASS.—The town is considering the purchasing of the works for $80,000, and it is stated that it will cost $25,000 to $35,000 to make the needed improvements.

CLINTON, MASS.—John W. Corcoran has been elected chairman and W. R. Dame treasurer of commissioners.

FOXBORO, MASS.—Geo. F. Williams, Clk., writes us that the town is awaiting legislative authority to increase the debt $10,000 to lay about three miles of 6-in. pipe.

NORTH ANDOVER, MASS.—Jas. W. Leitch, Tn. Clk., writes us that Loring N. Farnum, of E. Worthington, Jr., & Co., Boston, is making plans for works; supply from Great Pond; population, 3,742; Comrs., A. A. Currier, H. W. Field, and D. W. Carney.

WALTHAM, MASS.—L. Brown, Supt., writes us that the $10,000 appropriation is for such additions only as are required by the normal growth of city and that no special work is proposed for this year.

WINCHENDON, MASS.—Geo. M. Whitney, Tn. Clk., writes us that it is doubtful if any contracts for works will be awarded this year.

WORCESTER, MASS.—The council has authorized a loan of $50,000 for extensions.

FREEPORT, N. Y.—The following bids have been received for constructing works: Inman Bros., New York, $34,400; L. J. Richardson, Cortland, $34,400; J. O. Merritt, Port Chester, $35,944; F. S. Pecke, Flushing, $37,999; C. H. Lockwood, Jamaica, $35,200; Crawford & Co., Brooklyn, $42,300; John McNamee, Brooklyn, $39,000; Continental Const'n Co., New York, $37,835; Hydraulic Const'n Co., New York, $39,787; J. J. Moran, Brooklyn, $37,014.

HAMILTON, N. Y.—B. J. Steinson, Vil. Clk., writes us that $500 has been appropriated and a committee appointed to investigate certain sources of supply, but that in all probability nothing more will be done this year.

RIVERSIDE, N. Y.—A franchise has been granted, according to reports.

SYRACUSE, N. Y.—Bids are asked until April 13 for trenching and pipelaying, as stated in our advertising columns. W. R. Hill, Ch. Engr.

BERWICK, PA.—The Nescopeck Water Supply Co. has been incorporated to supply the township of Nescopeck, opposite this place; capital stock, $10,000; Treas., F. A. Witman.

EAST GREENVILLE, PA.—The citizens are reported to have voted to borrow $25,000 for works.

MORRISVILLE, PA.—A press report states that bonds have been sold and that the contract for works will soon be awarded.

SOUTH BETHLEHEM, PA.—The Mountain Water Co. has engaged E. H. Shipman to prepare plans for a reservoir. Important extensions of the mains are also contemplated.

BRUNSWICK, MD.—The question of issuing $40,000 of bonds will be voted upon in May; proposed supply from Potomac River; population, 3,000. G. H. Hogan, Tn. Clk.

FARMVILLE, VA.—J. R. Whitehead, Clk., writes us that a franchise has been granted to Dupuy & Roun, Roanoke.

SHENANDOAH, VA.—C. I. Stevens, Pres. Milnes Water Co., writes us that an engineer is preparing plans for works; supply from Shenandoah River; population, 2,000; no contracts yet awarded.

GRAFTON, W. VA.—S. M. Musgrove, Clk., writes us that the citizens have voted, 357 to 164, to issue $40,000 of bonds for works, but that no further steps have been taken; supply from Tygart's Valley River; population, 3,500.

PIEDMONT, W. VA.—Efforts are being made to secure works in Westernport, according to reports.

AIKEN, S. C.—The committee has recommended that a competent engineer be employed to examine the plans for the proposed works.

AUGUSTA, GA.—Plans are being considered for a stand-pipe; appropriation, $6,500.

VALDOSTA, GA.—Bids are asked until April 3 for pipe, specials, hydrants and valves. Plans are also being prepared by Arthur S. Krug, Engr., for a structural tower and tank to be erected soon.

PADUCAH, KY.—The mayor has been directed to open negotiations with a view to purchasing the works.

AKRON, O.—The commissioners have made a 20-year contract with the Akron Water-Works Co., the city to have the right to purchase the works at the end of each five years.

MILFORD CENTER, O.—The citizens have voted to issue bonds for $12,000 for works and electric lights.

NORTH BALTIMORE, O.—The North Baltimore Water & Electric Co. has been incorporated with a capital stock of $80,000.

GREENFIELD, IND.—The contract for works has been awarded to Snyder, Williams & Co., Dayton, O., at $23,873.

SUMMITVILLE, IND.—The Summitville Magnetic Water Co. has been incorporated by R. C. Howard, Maurice Warner, E. M. Blose, Moses Stone and J. D. Coffin to put in works at this place; capital stock, $5,000.

BATAVIA, ILL.—It is reported that the bid of the United States Wind Engine & Pump Co., Batavia, has been accepted for constructing works. A 12-in. cast iron intake will be extended into the Rock River 150 ft.——The city clerk writes that a statement of the bids received will be sent us this week.

DOWNER'S GROVE, ILL.—W. S. Shields, Title & Trust Bldg., Chicago, has been engaged as engineer for the proposed works.

GALVA, ILL.—Thos. Hudson, Chn. Com., writes us that no contracts will probably be awarded until about July 1; supply from artesian well; population, 2,500. Engr., Geo. C. Morgan, Chicago.

MARENGO, ILL.—C. P. Filmore, Cy. Clk., writes us that the council has decided to postpone the opening of bids for works until about May 1, and he adds: We receive more inquiries from the notice in your excellent paper than from all other sources combined.

OTTAWA, ILL.—We are informed that all details of contracts for new works have been settled with W. S. Reed & Co., contractors, The Rookery, Chicago, and that work is to be commenced at once. Bids are now being received by the contractors for the necessary materials, as specified in our issue of March 8.

SHANNON, ILL.—The citizens have voted, 90 to 48, to issue bonds for works.

STAUNTON, ILL.—The question of issuing bonds for works will be voted upon April 17, according to reports.

VENICE, ILL.—Bids are asked until June 1 for the sale of the works. The Granite City, Madison & Venice Water Co. has been granted a franchise on condition that it purchases the present plant, as stated March 15.

BARRON, WIS.—Press reports state that arrangements are being made for putting in works this spring.

KENOSHA, WIS.—W. S. Reed, Engr. for the new works, The Rookery, Chicago, informs us that the following bids were received: McArthur Bros., Chicago, $112,211; W. F. Rickett, Racine, Wis., $129,000; J. Williams, Kenosha, $112,500; J. G. Glaver & Co., Chicago, $134,900; I. W. Newcomer, Chicago, $99,348. No contract has yet been awarded.

WAUPUN, WIS.—W. F. Goodhue, Milwaukee, has submitted a report for works; estimated cost, $34,050. Proposed plan is to pump water from the Rock River to a stand-pipe 100 ft. high.

RIVER FALLS, WIS.—Allen P. Weld, Cy. Clk., writes us that the lowest bid for constructing the entire works was that of Fairbanks, Morse & Co., at $17,960. Some of the itemized prices will be published next week.

RED OAK, IA.—It is reported that bids will soon be asked for the improvements voted March 15, work including a stand-pipe, 1,000,000-gallon compound duplex pump, and a mile of new mains; estimated cost, $14,000. R. O. Newell, Cy. Clk.

SIOUX CITY, IA.—The fire chief has recommended that an additional storage reservoir be constructed and the mains extended.

DULUTH, MINN.—The plans for new works to be owned by the city have been completed. They include a water tower 150 ft. high and a contemplated pumping capacity of 20,000,000 gallons per day.

BEATRICE, NEB.—The test of a well has proven unsatisfactory, and other methods of securing a supply are being considered by the council.

FULLERTON, NEB.—The question of issuing $13,000 of bonds for works will be voted upon at the election in April.

HASTINGS, NEB.—Bids are asked until April 10 for about 15,000 ft. of 4-in. and 2,500 ft. of 8-in. cast iron water pipe, fire hydrants, plugs, boxes, lead, etc. W. W. Miles, Cy. Clk.

HUMPHREY, NEB.—A press report states that the citizens will soon vote on a proposition to issue bonds for works and an electric light plant.

OSCEOLA, NEB.—Nearly every resident of the village is said to have signed a petition for an election to vote on issuing bonds for works; estimated cost, $10,000.

TOBIAS, NEB.—A. A. Richardson, Lincoln, has prepared plans for works estimated to cost $7,500.

WILBER, NEB.—An engineer has been engaged to prepare plans for works; estimated cost, $17,000.

MINOT, N. DAK.—The city has sold $10,000 of bonds for works.

CHILLICOTHE, MO.—Van R. Caldwell, present local manager of the Chillicothe Water & Light Co., has been appointed receiver of the company, upon the application of the Knickerbocker Trust Co., New York.

BAIRD, TEX.—F. S. Gage, Treas., writes us that the contract for works has been awarded to M. Summers, at $9,565.

POPLAR BLUFF, MO.—Bids are asked until April 16 for constructing works, as stated in our advertising columns. Consult. Engr., Isaac A. Smith, St. Louis.

GLOBEVILLE, COLO.—The council has contracted with the Citizens' Water Co. for a plant to cost about $25,000. The contract stipulates that private consumers shall pay for ten years at the rate of 6 cts. per 1,000 gallons, according to reports.

NEW WHATCOM, WASH.—Jones & Miller have been awarded a contract for about 1,500 ft. of 24-in. wooden main, from the intake at Lake Whatcom, at $6,710. The pipe is to be made of 2-in. staves bound together by half-inch steel bands.

CAMPBELLTON, N. B.—J. & H. Black, bankers, St. John's, Que., and others, were in the city March 23 arranging with the council for the putting in of works by a private company, according to reports.

NIAGARA FALLS, ONT.—The commissioners have recommended that a large reservoir be constructed on Drummond Hill.

ARTESIAN WELLS.

FARGO, N. DAK.—The water committee will receive bids until April 2 for sinking an artesian well.

CORSICANA, TEX.—The Corsicana Water Development Co. has awarded a contract for three wells 2,300 ft. deep to the American Well & Projecting Co., Salina, Kan., at $30,000; wells to be cased the entire depth with 6-in. standard wrought iron pipe, to weigh at least 18 lbs. per lin. ft. If the wells are completed to 3,000 ft. the contract price is to be $55,200.

IRRIGATION.

GLENWOOD SPRINGS, COLO.—The Denver "Republican" states as follows: A project is on foot here for the reorganization of the Grand River Ditch Co., and the completion of this undertaking, which was stopped by the financial stringency last fall. It is stated on good authority that $50,000 has been deposited in the German National Bank, Denver, for the purpose of completing the ditch. If so, it will certainly be finished this spring, only a mile or so yet remaining to be constructed. If this result can be accomplished it will bring nearly 30,000 acres of fine fruit lands under water this year, all of which would quickly be settled upon. It is also said that the ditch itself will be bonded, and the capitalists who have already invested be thus secured.

ELLENSBURG, WASH.—H. K. Owens has been engaged to make new surveys and report on a proposed irrigation ditch near this place.

ESCONDIDO, CAL.—E. F. Tabor, District Engr., writes us that the $250,000 of bonds have been sold to I. E. Doty, of Nebraska, at 91 cts., and the contract for the construction of the entire system awarded to the same person. The bids are published under Contract Prices.

SAN DIEGO, CAL.—A press report states as follows: Herbert L. Emery has sold his ranch in Pine Valley to the Pine Valley Consolidated Water & Land Co., together with the well known Pine Valley reservoir site and water rights. Surveys have shown that a perfect site exists for a dam capable of holding 8,000,000,000 gallons of water, 2,000,000,000 more than the Sweetwater reservoir. The Pine Valley Co., which is composed of Emery, his brother, Gen. Ell H. Murray, and others, is about to make arrangements to develop the splendid water rights on the land and to take advantage of the reservoir site. The dam, as proposed to be built, will be 125 ft. in height. The reservoir's site is an oval valley ending in a narrow canyon.

NEW COMPANIES.—The Nauman Lake Reservoir Co., Greeley, Colo.; $2,000; A. A. Dicker, J. G. Benton, E. H. Benton.——La Junta Canal Co., Tucson, Ariz.; $400,000; A. J. Davidson, Ozro Haskins, F. C. O'Brien.

SEWERS.

AUGUSTA, ME.—The mayor advises the employment of an engineer to make surveys for a system.

BANGOR, ME.—Plans have been prepared for a trunk sewer, 4,000 to 5,000 ft. long; estimated cost, $13,000.

WINDSOR, VT.—H. H. Blanchard, Vil. Clk., writes us that plans for a system, prepared by G. H. Leland, have been adopted; estimated cost, $23,585, of which only $5,381 will probably be expended at present.

ATTLEBORO, MASS.—It is reported probable that a committee will be appointed to investigate the question of a system.

BROCKTON, MASS.—The commissioners have been directed to ask for bids for constructing sewers, with and without the employment of Brockton laborers at $2 per day of nine hours.——Bids are asked until April 9 for constructing section 8 of the city sewerage system for constructing section 8 of the city sewerage system, as stated in our advertising columns. F. Herbert Snow, Cy. Engr.

CAMBRIDGE, MASS.—Bids are asked until March 31 for constructing 1,420 ft. of sewer in Commercial Av., in East Cambridge. L. M. Hastings, Cy. Engr.

FITCHBURG, MASS.—The Council has voted to contract with the United States Sewage Filtration Co., at $20 a day for a 90-day's trial of its system of sewage disposal.

MEDFORD, MASS.—T. H. Barnes, Engr. Board Sewer Comrs., writes us that the sewer commissioners have recommended an appropriation of $60,000, to be used where most needed, but that no action has yet been taken by the council.

MELROSE, MASS.—Authority has been asked to issue bonds for $100,000 for sewers.

NORTHAMPTON, MASS.—The commissioners have decided to ask for $35,000 for sewer construction.

NEW HAVEN, CONN.—The committee has recommended the construction of sewers in four streets.

NEW YORK, N. Y.—Bids are asked until April 5 for constructing sewers in two streets. L. F. Haffen, 2,622 Third Ave., Comr. St. Impvts., Wards 23 and 24.

UNION HILL, N. J.—Plans have been prepared by J. J. Tallon for a proposed system in the north part of the town.

MEADVILLE, PA.—It is proposed to advertise for bids for constructing an outlet sewer, plans for which have been completed.

LOCK HAVEN, PA.—Plans for a system have been completed by Voorhees & Witmer, Buffalo, N. Y.

PHILADELPHIA, PA.—Bids are asked until April 2 for constructing main and branch sewers. J. H. Windrim, Dir. Pub. Wks.

READING, PA.—The contract for the sewage pumping plant has been awarded to the Pennsylvania Sanitary Sewage Co., Philadelphia, at about $150,000. The bids were published in our issue of Feb. 8.

RICHMOND, VA.—It is reported probable that bids will be asked for $70,000 of sewer work.

ATLANTA, GA.—It is proposed to construct a brick sewer in Third St., to cost about $5,000.

MERIDIAN, MISS.—Bids are asked until May 1 for constructing a system, as stated in our advertising columns. I. A. Mooser, Cy. Clk.

KNOXVILLE, TENN.—It is reported that plans have been completed for a system in West Knoxville, and that bids will soon be asked for the construction.

HENDERSON, KY.—The question of a system is being discussed by the council. The committee has recommended that Geo. E. Waring, Jr., be engaged to prepare plans.

BARBERTON, O.—W. A. Johnson, Vil. Engr., has prepared plans for a system estimated to cost $18,000, with outlet into the Tuscarawas River.

CINCINNATI, O.—Bids are asked by the board of administration until April 23 for constructing a trunk sewer in Bates Run.

CLEVELAND, O.—Bids are asked until April 4 for constructing sewers in seven streets. J. H. Farley, Dir. Bd. Pub. Wks.

HAMILTON, O.—The state senate has passed a bill authorizing an issue of $100,000 of bonds for sewers and for a sewage pumping works.

IRONTON, O.—It is proposed to issue $50,000 of bonds for sewers and streets.——Plans have been adopted for sewers in one district.

NELSONVILLE, O.—L. E. Chapin, Consult. Engr., Canton, informs us that the lowest bid for the proposed sewers was that of Myer & Perido, Lancaster, O., at $16,993.

EVANSTOWN, IND.—Bids are asked until April 3 for constructing a sewer in Pennsylvania St. E. E. Clark, Clk. Bd. Pub. Wks.

HUNTINGTON, IND.—The contract for the Flint Creek sewer has been awarded to Keefer & Hallwood at $43,985, being $11.63 per ft. The other bids were as follows: McConnell & Filton, $26.40 per ft.; J. W. & Jos. Karch, $26; Wilding, Derhermer & Co., $20.96; Fisher & Bailey, $20.38; L. C. Mitten & Co., $22.97; Reuben Murphy, $18.90.

PONTIAC, MICH.—The highest bid for $25,000 of sewer bonds was that of A. W. Harris & Co., Chicago, at $25,853, if the bonds bear 5% interest.

ST. JOHNS, MICH.—D. H. Hunt, Vil. Clk., writes us that the village has voted to issue $30,000 in bonds for sewers to be issued in blocks of $5,000 as needed.

MENASHA, WIS.—Bids are asked until May 1 for constructing a sewer. John Landgraf, Cy. Clk.

DULUTH, MINN.—The assistant city engineer is making plans for sewers in certain parts of the city.

GRAND JUNCTION, COLO.—The citizens will vote at the spring election on issuing $25,000 bonds for a system, according to reports.

HALIFAX, N. S.—It is proposed to authorize the city treasurer to issue $20,000 of bonds for building sewers.

STREETS.

HOLYOKE, MASS.—Bids are asked until April 3 for furnishing from 5,000 to 10,000 lin. ft. of granite curbing; also for brick sidewalks. R. B. Holmes, Cun. Com.

ALBANY, N. Y.—Bids are asked by the board of contract until April 2 for paving and curbing Hawk St. with dimension granite blocks.

BROOKLYN, N. Y.—Bids are asked until April 10 for grading and paving Leonard St. with cobblestones. A. T. White, Comr. Cy. Wks.

LOCKPORT, N. Y.—C. H. Cornes, Cy. Engr., writes us that bids will be asked in a few weeks for paving Buffalo St. with brick, 2,700 sq. yds.

ALLEGHENY, PA.—Contracts for paving 13 streets have been awarded as follows: Sicilian Asphalt Paving Co., 10 streets with sheet asphalt, total $190,283; Booth & Flinn, two streets with Ligonier blocks, $25,402; Sloan & McIlvain, one street with sheet asphalt, $5,303.

ALTOONA, PA.—An ordinance has been passed by the council to pave 3,120 sq. yds. in Ninth St. with brick upon 6 ins. of concrete.

CHESTER, PA.—Bids are asked until March 31 for a supply of crossing stone, gutter stone, brick, broken stone, cement and gravel. Mordecai Lewis, Cy. Clk.

PITTSBURG, PA.—The public works committee has recommended the improving of eight streets.

WILKINSBURG, PA.—It is reported probable that an election will be held to vote on issuing $50,000 of bonds for paving.

BALTIMORE, MD.—Bids are asked until April 2 for furnishing 14,000 lin. ft. of gutter stones, also for sand; and until April 6 for repaving McCulloh St. with asphalt blocks. A. E. Smyrk, Cy. Comr.

JACKSONVILLE, FLA.—It is proposed to pave Maine and Laura Sts. with brick; estimated cost, $43,730. W. C. West, Secy. Bd. Pub. Wks.

MONTGOMERY, ALA.—Bids are asked until April 16 for paving with asphalt, granite and brick; also for macadamizing several streets. D. W. Ford, St. Comr.

BROOKLYN VILLAGE, O.—Bids are asked until April 17 for about 3,200 lin. ft. of brick paving. C. N. Collins, Vil. Clk.

CLEVELAND, O.—Bids are asked until April 27 for paving four streets with dressed block Medina sandstone, and two streets with brick. J. H. Farley, Dir. Pub. Wks.

ST. BERNARD (P. O. Ludlow Grove), O.—Bids are asked until April 5 for grading and macadamizing two streets. J. G. Overman, Clk.

HAUGHVILLE, IND.—Bids are asked until April 4 for grading and graveling Bismarck Ave. J. N. Dugan, Tn. Clk.

INDIANAPOLIS, IND.—The Indiana Bermudez Asphalt Co. has been incorporated with a capital stock of $24,000.

JOLIET, ILL.—Bids are asked until April 16 for paving about 2,500 lin. ft. of Center St. with two courses of brick.——O. R. Rauchfuss, Cy. Engr., writes us that ordinances have been passed for paving Cass St., 5,200 × 42 ft., with a single course of brick upon 4 ins. of concrete, and that ordinances have been ordered for paving Richards St. and Eastern Ave. with a single course of brick.

RACINE, WIS.—The city will vote at the coming election on issuing $50,000 in bonds, one-half for paving and the rest for general improvements.

KEOKUK, IA.—The contract for paving Main St. with brick has been awarded to the Des Moines Brick Mfg. Co., at $19,899, according to reports.

WATERLOO, IA.—Bids are asked until May 7 for paving certain streets with brick and for stone curbing. H. C. Schultz, Cy. Clk.

ST. PAUL, MINN.—Bids are asked until April 3 for repairing paved streets during 1894. T. A. Prendergast, Cy. Clk.

ST. LOUIS, MO.—The board of street improvements has recommended the paving of five streets with telford macadam and two each with brick and asphalt; estimated cost, $150,000.

ELECTRIC LIGHT AND POWER.

GENESEO, N. Y.—Bids are asked by the village trustees for an electric light plant, according to reports.

CALIFORNIA, PA.—It is reported that the trustees will begin work upon an electric light plant early this spring.

CHESTER, PA.—Bids are asked until March 31 for lighting the streets for one year. G. W. Howard, Mem. Com.

MILLERSBURG, PA.—Plans are being made for an electric light plant. The company has been organized two years.

CHARLOTTE, MICH.—A 5-years' contract has been made with the electric light company at $6.50 per month for each arc light, lights to burn from twilight until midnight.

EVART, MICH.—The citizens have voted to bond the town for an electric light plant.

SPRINGFIELD, ILL.—The question of putting in a municipal electric light plant is being considered by the council.

FAYETTE, IA.—It is reported that this place has voted to put in an electric light plant.

DENVER, COLO.—The county commissioners are reported as planning to put an independent electric lighting plant in the courthouse.

NEW COMPANIES.—Ephrata Gas, Light, Heat & Power Co., Ephrata, Pa.; $50,000; Treas., J. G. Schoenfelber.—American Electric Co., Toledo, O.; $10,000. ——Eaton Electric Light, Power & Ice Mfg. Co., Eaton, O.; $50,000.——Bro kville Electric Light Co., Eau Claire, Wis.; $15,000; R. E. Rust, G. T. Thomson, Fitch Gilbert.——Eureka Lighting Co., San Francisco, Cal.; $250,000; J. W. Livingston, W. D. Clark, Henry Williams, H. N. A. Miller.——Huntsville Electric Light & Ice Co., Huntsville, Tex.; $6,500; T. H. Ball, J. G. Ashford, T. C. Gibbs, C. G. Barrett.——Colorado Springs Gas & Electric Co., Colorado Springs, Colo; $150,000. ——Bangor Electric Light, Heat & Power Co., Bangor, Pa.; $30,000; Treas., B. F. Miller.

CONTRACT PRICES.

CEMENT.—Malden, Mass.—The following bids have been received for cement: E. E. Locke, 3,200 bbls. American natural hydraulic, at $1.08, and 2,800 bbls. Portland, at $2.10; W. G. Nash, $1.05 and $2.10, respectively; J. A. Davis & Co., $1.20 and $2.20.

Beverly, Mass.—Jas. Fairfield, Salem, has been awarded a contract for 1,500 bbls. Rosendale cement, at $1.07 and $1.12 per bbl., and 500 bbls. Portland, at $2.17, delivered.

BRICK.—Beverly, Mass.—A contract for 450,000 brick for sewer construction has been awarded to the Granite State Brick Co., Boston, at $8.25 per M. f. o. b. cars, the other bids being as follows: W. C. Norcross, Boston, $9.20, or $9.70 delivered on work; David Crowell & Son, Beverly, $9.25 on cars; W. T. Trask, Danvers, $8.50 on work; G. C. Blakely & Bros., Lynn, $8 on cars; Ed. Carr, Danvers, $8 on work; A. W. Bryne, West Medford, $7.90 on cars; Jas. Fairfield, Salem, $7.25 on wharf.

ASPHALT PAVING.—New York, N. Y.—The commissioner of public works has awarded ten contracts for paving with Trinidad asphalt upon the present stone-block pavement, at $398,226; estimate, $400,394. The contract was awarded to the lowest bidder in each case and the bids were as follows, 1 being that of the Sicilian Asphalt Paving Co.: 2, Barber Asphalt Paving Co.; 3, Warren-Scharf Asphalt Paving Co.:

	1.	2.	3.
Avenue C, 12,260 sq. yds.	$4.86	$4.79	$4.95
Bridge stone, 30 sq. ft.	.52	.53	.50
Curbstone, 1,640 lin. ft.	.56	.49	.50
129th and 130th Sts., 13,000 sq. yds.	3.79	3.79	3.62
Curbstone, 1,250 lin. ft.	.56	.49	.50
79th and 80th Sts., 11,230 sq. yds.	3.60	3.69	3.59
Bridge stone, 100 sq. ft.	.52	.53	.50
Curbstone, 1,080 lin. ft.	.54	.49	.50
19th, 31st and 37th Sts., 7,885 sq. yds.	3.80	3.67	3.92
Bridge stone, 50 sq. ft.	.52	.53	.50
Curbstone, 1,525 lin. ft.	.54	.49	.50
Norfolk and Ridge Sts., 12,300 sq. yds.	3.86	3.83	4.05
Bridge stone, 90 sq. ft.	.52	.53	.50
Curbstone, 3,800 lin. ft.	.54	.49	.50
51st, 56th and 6-th Sts., 5,840 sq. yds.	3.65	3.63	3.74
Bridge stone, 70 sq. ft.	.52	.53	.50
Curbstone, 280 lin. ft.	.54	.49	.50
Sheriff and 7th Sts., 13,900 sq. yds.	3.89	3.87	4.05
Bridge stone, 30 sq. ft.	.52	.53	.50
Curbstone, 3,600 lin. ft.	.54	.49	.50
8th, 9th and 10th Sts., 13,400 sq. yds.	4.89	4.39	4.95
Curbstone, 3,650 lin. ft.	.54	.49	.56
Elm, Franklin and White Sts., 2,900 sq. yds.	4.54	4.29	4.95
Curbstone, 440 lin. ft.	.54	.49	.50
73d and 87th Sts., 5,750 sq. yds.	3.74	3.63	3.74
Bridge stone, 40 sq. ft.	.52	.53	.50
Curbstone, 300 lin. ft.	.54	.49	.50

GRANITE BLOCK PAVING.—New York, N. Y.—Eight contracts have been awarded for paving with granite blocks upon 6 ins. concrete, at $214,220; estimate, $246,723. The itemized bids were as follows:

Bids Received for Granite Paving, New York, N. Y.

	F. Thilemann, Jr.	W. B. Leddy.	J. G. Smith.	J. A. Gearty.	Matthew Baird.	Jas. Pollock.	Christian Lauer.	P. H. McCullough.
14th St., 12,300 sq. yds.	$3.24	$3.05*	$3.07	$3.50	$3.19	$3.09	$....	$....
Bridge stone, 2,480 sq. ft.	.48	.45	.44	.50	.49	.44	....	....
Concrete, 1,580 cu. yds.	.00	.01	.01	.01	.01	.01	....	....
Curbing, 1,600 lin. ft.	.48	.45	.45	.50	.49	.43	....	....
Madison Ave., 7,440 sq. yds.	3.58	...	3.20	3.20	3.15*	3.25	2.85	3.20
Bridge stone, 3,600 sq. ft.	.50	...	.44	.50	.49	.45	.55	.45
Concrete, 1,050 cu. yds.	.00	...	.01	.01	.01	.01	4.50	.01
Curbing, 150 Lin. ft.	.50	...	.45	.60	.49	.45	.60	.50
Duane et al. Sts., 3,045 sq. yds.	3.70	...	3.40*	3.30	3.47	...	...	...
Bridge stone, 1,970 sq. ft.	.50	...	.45	.60	.55	...	...	...
Concrete, 510 cu. yds.	.00	...	.01	.01	.01	...	...	...
Curbing, 265 lin. ft.	.50	...	.20	.60	.50	...	...	...
34th St., 7,750 sq. yds.	3.26	...	3.07*	3.19	3.19	...	...	3.25
Bridge stone, 1,850 sq. ft.	.50	...	.44	.55	.49	...	...	.45
Concrete, 1,030 cu. yds.	.00	...	.01	.01	.01	...	...	.01
Curbing, 1,200 lin. ft.	.50	...	.45	.55	.49	...	...	.00
57th St., 5,950 sq. yds.	3.58	3.15***	3.10*	3.43	3.27	3.15	2.80	3.20
Bridge stone, 1,050 sq. ft.	.50	.45***	.45	.60	.49	.45	.55	.45
Concrete, 1,015 cu. yds.	.00	.01***	.01	.01	.01	.01	4.50	.01
Curbing, 250 lin. ft.	.50	.47***	.25	.60	.49	.45	.60	.50
W. B'way, 13,100 sq. yds.	3.36	3.12*	3.33	3.23	3.24	...	...	3.16**
Bridge stone, 6,200 sq. ft.	.50	.45	.45	.50	.49	...	...	.55**
Concrete, 1,880 sq. yds.	.00	.01	.01	.01	.01	...	...	.01**
Curbing, 450 lin. ft.	.50	.45	.45	.50	.49	...	...	.40**
Prince et al. Sts., 5,560 sq. yds.	3.60	...	3.40*	3.43	3.49	...	...	...
Bridge stone, 4,800 sq. ft.	.50	...	.45	.55	.55	...	...	...
Concrete, 785 cu. yds.	.00	...	.01	.01	.01	...	...	...
Curbing, 625 lin. ft.	.50	...	.45	.55	.50	...	...	...
Broome St., 8,620 sq. yds.	3.50	3.05*	3.15	3.23	3.27	3.30	...	3.33**
Bridge stone, 3,880 sq. ft.	.50	.45	.44	.50	.49	.45	...	.40**
Concrete, 1,370 cu. yds.	.00	.01	.01	.01	.01	.01	...	.01**
Curbing, 1,200 lin. ft.	.50	.45	.40	.50	.49	.45	...	.50**

*Lowest bid, awarded contract. **Bids made by M. F. Fitzgerald. ***This bid was made by T. F. Myers.

SEWERS.—Beverly, Mass.—Ernest W. Bowditch, Engr., Boston, informs us that the following contract has been awarded to F. A. Snow, Providence, R. I.:

Earth Work.			
0 to 8 ft.,	5,000	cu. yds., at	$ .60
8 to 14 ft.,	1,500	" "	.80
14 to 20 ft.,	100	" "	1.75
Tunnel,	550	" "	4.00
Excavation below grade			2.00
Refilling			2.00
Rock Work.			
0 to 8 ft.,	900	cu. yds., at	4.00
8 to 14 ft.,	350	" "	5.00
14 to 20 ft.,	100	" "	6.00
Tunnel,	100	" "	6.00
Brick Work.			
In trench,	800	" "	6.00
Tunnel,	60	" "	7.00
Concrete Work.			
In trench,	100	" "	5.00
Tunnel,	200	" "	6.00
Stone Work.			
In trench			3.75
Tunnel,	200	cu. yds., at	4.00
Pipelaying,	3,700	ft., "	.40
Underdrain,	1,000	ft., "	.50
Spruce lumber for foundations,		at	40.00
Laying 24-in. pipe,	2,100	ft., "	.15
Sheeting, left in,		"	20.00
Spruce piles,		"	.30
Oak "		"	.40
Paving,	80	sq. yds., "	2.50
Laying 40-in. pipe,	700	ft., "	1.25
Amount of bid			$22,695

The other total bids were as follows: Robt. A. Davis and J. J. Garra, Boston, $30,359; F. E. Shaw & Co., Providence, $39,690; Lucian A. Taylor, Boston, $42,884; Bates & Welch, Salem, $33,793; Whitmore & Fenton, Lynn, $30,810; J. N. Peterson, Salem, and Thos. Fitzgibbon, Beverly, $35,635; James Heath, Lynn, $29,160; Frank L. Allen, Worcester, $46,184; A. W. Bryne, West Medford, $32,575; Weaving, Booth & Co., Boston, $29,680; Metropolitan Construction Co., Boston, $24,582; John Sheehan, Lynn, $22,261; Jones & Meehan, Jamaica Plain, $42,195.

SEWER PIPE.—Meriden, Conn.—W. S. Clark, Cy. Engr., writes us that a contract for furnishing vitrified sewer pipe has been awarded to the H. Wales Lines Co., Meriden, at the following prices: 12-in., 3,100 ft., at 21.6 cts. per ft.; 10-in., 910 ft., at 16.7 cts.; 8-in., 19,550 ft., at 11.5 cts.; 6-in., 1,000 ft., at 7.6 cts.; 12-in. Y's, 240, at 57 cts. extra; 10-in., 60, at 44 cts.; 8-in., 1,300, at 31.4 cts.; 6-in., 20, at 21.5 cts.

Malden, Mass.—Bids were opened March 15 for 22,300 ft. of 8 to 18-in. extra bell sewer pipe, with branches, and for 63,000 ft. of 4 to 8-in. standard bell pipe, with branches, the bids being as follows: E. E. Locke, 60% and 73% discount from list price, respectively, for the two kinds; total $17,321; W. G. Nash, 55% and 72%; total, $16,563; Perrin & Seamans, 74½% for each; total, $13,707; Boston Building Material Co., 71% and 72%; total $15,267; and an unitemized bid by the latter company at 74% and 76%; total.

Beverly, Mass.—E. W. Bowditch, Engr., Boston, informs us that a contract for earthen sewer pipe has been awarded to C. A. Lawrence, Beverly, at 72½ off list price; total $773. The other bids were Jas. Fairfield, Salem, 65%; Waldo Bros., Boston, 72½% and 65%; Portland Stoneware Co., Boston, 55% and 75%; David A. Lewis, Boston, 65%.

WATER-WORKS.—Nelsonville, O.—A. E. Price, Clk. Com., writes us that the contract for works has been awarded the Shaw-Kendall Co., Toledo, at the following prices: Pipe, $18.50 per ton; special castings, 2¼ cts. per lb.; 4-in., 6-in., 8-in., 10-in. and 12-in. valves, $6.60, $9.90, $16.50, $24 and $31.35 each, respectively; boxes, $3; hydrants, $22; laying 4-in., 6-in., 8-in., 10-in. and 12-in. pipe, 10½ cts., 13¾ cts., 16½ cts., 21 cts. and 25 cts. per lin. ft., respectively; supply well, $2,500; building and stock, $1,648; two 750,000-gallon pumps and two 24 × 14 boilers, complete, $4,437; 800,000-gallon reservoir, $8,920; complete plant, $37,185.

SEWERS.—New York, N. Y.—Commissioner Daly has awarded contracts for 12 sewers, the largest being for a sewer in Marginal St., with branches, the contract for which was awarded to Wm. E. Dean, at $20,083, the bids being as follows:

	B. Mahon.	P. J. Kearns.	L. Martin.	P. Casey.	W. E. Dean.	F. Thilemann, Jr.	J. Slattery.	W. F. Cunningham.
48×32 ins., 800 ft.	$16.00	$14.00	$22.35	$15.00	$14.80	$14.00	$35.00	$13.50
42×28 ins., 1,000 ft.	16.00	11.00	14.00	15.00	5.21	14.00	30.00	12.50
" 515 ft.	12.00	8.00	7.40	9.00	4.51	10.00	20.00	10.00
Receiving basins, 6	140.00	10.00	125.00	150.00	100.00	150.00	170.00	150.00
12-in. pipe culvert, 80 ft.	1.00	1.00	1.00	1.00	1.00	1.50	1.50	.....
Timber for bracings, 3,000 ft. B. M.	20.00	40.00	10.00	35.00	10.00	18.00	20.00	.....
Total amounts	$35 960	$26,580	$36,551	$32,720	$20,083	$31,424	$69,500	$29,350

Boone, Ia.—The contract for sewers in district No. 1 has been awarded to Geo. J. Baer, at $70,605, as stated last week. R. M. Mitchell, Cy. Engr., informs us that the bids were as follows:

Syracuse, N. Y.—W. R. Hill, Ch. Engr., informs us that a contract for cast iron pipe has been awarded to the Buffalo Cast Iron Pipe Co. as follows: 36-in. straight pipe, 460 tons, at $17.70 per ton; 30-in., 300 tons, at $17.84; 24-in., 570 tons, at $18.64; 20-in., 300 tons, at $19.15; 16-in., 1 ton, at $19.70; 12-in., 20 tons, at $20.03; 10-in., 20 tons, at $20.22; 8-in., 20 tons, at $20.90; 6-in., 30 tons, at $21.21; 4-in., 1 ton, at $23.30; special castings, 110 tons, at $40; total, $36,166. The other total bids were as follows: Reading Foundry Co., $36,431; National Foundry & Pipe Works, $37,008; Dennis Long & Co., $38,144; Howard-Harrison Iron Co., $38,557; Anniston Pipe & Foundry Co., $40,490; Camden Iron Works, $40,564; Henry W. Miller and T. Murray, Utica, $40,957; McNeal Foundry & Pipe Co., $41,215.

Beverly, Mass.—The contract for 77.14 tons of 40-in. cast iron pipe has been awarded to R. D. Wood & Co., at $23 per ton of 2,240 lbs., or $21.90 per ton by vessel. Engr., E. W. Bowditch, Boston.

CATCH BASIN AND MANHOLE CASTINGS.—Beverly, Mass.—The Le Baron Foundry Co., Middleboro, has been awarded a contract for catch basin and manhole castings at $6.47 and $7.47 each for the catch basins and $6.47 for the manholes, and the Mechanics' Iron Foundry, Roxbury, a contract for traps, at $3.24 each for the old style and $4.11 for the new. The other bidders were Arthur A. Ford, Boston; Builders' Iron Foundry Co., Providence, R. I.; G. W. & F. Smith, Boston; Alonzo H. Smith, Salem; Wm. S. McIntire, Salem; Nobie Stone Co., Lynn; Condor Iron Foundry Co., East Boston; W. H. Carberry, Boston; Osgood & Hart, Charlestown; Union Iron Wks., Lynn; Boston Double Catch Basin, Sewer & House Trap Co.

MISCELLANEOUS CONTRACTS AND SUPPLIES.

IRON.—Baltimore, Md.—Bids are asked until April 2 for 50 tons of wrought and cast iron, being bridge and gutter plate material. A. E. Smyrk, Cy. Comr.

THE PETERSBURG IRON WORKS CO., of Petersburg, Va., has been incorporated with a capital of $100,000, and will in a short time start up the iron works formerly owned and operated by H. T. Morrison. Prospects for spring are reported as being bright in this section. Pres., C. P. E. Burgwyn.

THE HARVEY BOILER WORKS, Harvey, Ill., have been awarded a contract for furnishing and erecting the standpipe, 20 ft. in diameter by 80 ft. high, on a tower 30 ft. high for the water-works at Lebanon, Ind., and also to furnish the boilers for the Rochester, Ind., water-works.

GEORGE E. NYE, 74 West Washington St., Chicago, has bought out all patterns and business of the Nye Steam Vacuum Pump Co., recently known as the Columbian Steam Pump Co., and will conduct the entire business of both companies in connection with the manufacture of his improved Nye steam vacuum pump.

THE AMERICAN WELL & PROSPECTING CO., of Salina, Kan., is sinking two wells 3,000 ft. deep, one for the water-works at Hubbard City, Tex., and one for the State Orphans' Asylum at Corsicana, Tex.; also, two 2,000-ft. wells, one for the city of Paris, Tex., and a private well at Temple, Tex. The general manager of the company is Mr. H. G. Johnston, M. Am. Soc. C. E.

THE BEAMLESS BRAKE CO., of Bloomsburg, Pa., has an order from the New York, Susquehanna & Western R. R. for 50 sets of its beamless brakes to be applied to the new coal cars recently ordered. This road has had the brake on trial for over a year and has lately put it on several cabooses. The above cars are a portion of the order for 200 cars placed with the Bloomsburg Car Co.

THE TRUAX MFG. CO., of Denver, Colo., is introducing automatic dump ore cars, which are made of steel, provided with chilled wheels, and have a dumping arrangement by which the ore is held until the car is tipped to an angle of 12°. In this way the truck can be set nearer the dump end, affording an easier dump than the ordinary car and giving a more equal wear on the wheels and axles.

THE TRUSS RAIL JOINT CO., of Chicago, reports that of 1,258 Truss joints laid in the spring of 1889 on track with 1% grade, 2° curves, and gravel ballast, the only breakages reported up to Jan. 1, 1894, were 47 truss rods out of 2,516, and of these 15 were broken by derailed wheels. There have been no breakages of rails at bolt holes, and only three rails have been taken out; these were split about 6 ft. from the ends. The cost of the broken truss rods was $4.58. This joint was illustrated and described in our issue of Dec. 8, 1889.

BIDS RECEIVED AT BOONE, IA., MARCH 14, 1894, FOR SEWERS IN DISTRICT NO. 1.

	Pipe. 18-in., 6,395 ft.	15-in., 7,710 ft.	12-in., 5,700 ft.	10-in., 4,125 ft.	8-in., 21,610 ft.	6-in., 80,051 ft.	C. I., laid, 19 tons.	Manholes, 126.	Flush tanks, 5-in. siphon, 36.	Flush tanks, 8-in. siphon, 14.	Pump holes, 360.	Pumps, 2.	½-in. service pipe, 4,100 ft.	Valves and stop box for each flush tank, 15.	Drain tile, 3 and 4-in., 20,000.	Repaving, 200 lin. ft.	Rubble masonry, 2.8 cu. yds.	Stone paving, 9 sq. yds.	Rock excav. per lin. ft., 1 ft. deep.	Totals.
Geo. J. Baer, Kansas City, Mo.	$1.15	$0.90	$0.76	$0.58	$0.45	$0.33	$45.00	$35.00	$60.00	$65.00	$7.50	$50.00	$0.25	$10.00	$0.05	$0.50	$8.00	$1.00	$0.50	$70,605
Dubuque Const'n Co., Dubuque, Ia.	1.45	1.10	.80	.52	.46	.33	60.00	35.50	60.00	72.35	4.35	5.00	.20	20.00	.03	.10	6.00	.75	.50	72,942
John Hurley & Co., Des Moines, Ia.	1.24	1.11	.75	.51	.45	.37	50.00	33.00	75.00	75.00	6.00	50.00	.15	1.25	.05	.50	6.50	2.00	.25	75,008
J. L. Black, Omaha, Neb.	1.40	1.05	.80	.52	.44	.35	80.00	52.00	62.00	76.00	8.00	25.00	.25	12.00	.10	.60	10.00	3.00	.70	78,958
McAuley, Fleming & Wright, Des Moines, Ia.	1.35	.95	.75	.62½	.52	.41	95.00	30.00	90.00	95.00	9.00	65.00	.20	6.00	.05	.10	3.50	1.50	.20	82,347
Hoover & Mason, Kansas City, Mo.	1.98	1.40	.65	.50	.33	.35	112.50	68.00	78.00	85.00	8.90	48.00	.32	4.80	.05½	.48	8.00	1.60	.96	86,210
T. W. Kinser & Son, Terre Haute, Ind.	1.70	1.20	.95	.70	.60	.40	80.00	30.00	50.00	60.00	10.00	30.00	.15	10.00	.15	2.00	10.00	4.00	.50	89,241
Tillson & McHugh, Omaha, Neb.	1.70	1.35	1.15	.53	.50	.40	90.00	50.00	70.00	80.00	15.00	30.00	.10	9.00	.05	.50	8.00	2.00	1.00	91,642
Mall & Doan, Aurora, Ill.	1.50	1.10	.85	.60	.55	.40	50.00	35.00	70.00	75.00	10.00	30.00	.15	3.00	.05	.25	6.00	1.45	....	83,629
N. P. Glaun Const'n Co., Galesburg, Ill.	1.78	1.35½	1.09	.55½	.54¾	.47⅜	40.00	35.00	50.00	60.00	10.00	10.00	.10	5.00	.03	.05	10.00	2.00	.18	93,029
McGarock & Daley, Omaha, Neb.	2.50	1.25	1.00	.90	.55	.40	75.00	50.00	70.00	80.00	2.00	20.00	.25	4.00	.03	2.00	12.00	2.50	....	93,209
Katz & Crandall, Omaha, Neb.	1.57	1.22	.97	.67	.57	.47	57.90	43.00	92.00	97.00	9.00	37.00	.37	4.00	.05	.50	8.00	4.00	.25	94,918
Rockford Const'n Co., Rockford, Ill.	1.90	1.40	1.10	.64	.55	.44	75.00	42.00	90.00	100.00	8.25	30.00	.18	15.00	.08	.30	10.00	3.00	.40	97,027
W. W. Cook, Fostoria, O.	2.00	1.60	1.20	1.20	.75	.40	50.00	40.00	80.00	90.00	6.00	30.00	.10	5.00	.05	.50	8.00	.50	.50	99,106
Wickham Bros., Council Bluffs, Ia.	1.80	1.60	1.20	.60	.50	.45	50.00	40.00	85.00	90.00	15.00	50.00	.15	20.00	.15	.10	8.00	2.50	.50	99,780
Anderson & Lindquist, St. Paul, Minn.	2.80	1.60	1.25	.70	.65	.40	200.00	40.00	70.00	75.00	8.00	15.00	.35	3.00	.07	.75	10.00	3.00	5.00	104,726
Smith, Grant & Co., Chicago, Ill.	1.95	1.45	1.15	.73	.59	.52	300.00	55.00	60.00	70.00	6.00	50.00	.30	20.00	.05½	7.00	10.00	15.00	....	109,815
Patrick McDonald, Kansas City, Mo.	2.60	1.50	1.25	.65	.58	.55	140.00	30.00	96.00	100.00	10.00	100.00	.30	10.00	.06	.20	10.00	5.00	10.00	112,349
John Clyne, West Duluth, Minn.	2.70	1.76	1.30	1.10	.75	.42	48.00	55.00	120.00	130.00	25.00	20.00	.28	2.00	.02	.50	5.00	1.00	.20	117,335
F. McCann & Co., Dubuque, Ia.	2.10	1.85	1.58	.80	.75	.60	95.00	40.00	90.00	100.00	17.00	85.00	.25	10.00	.15	1.10	3.00	1.00	.60	126,424
Kissack & Muir, Chicago, Ill.	3.39	2.58	1.81½	1.02½	.96½	.65½	124.00	40.00	90.00	100.00	14.00	50.00	.10	15.00	.06	.25	6.00	1.00	.60	148,689

IRRIGATION SYSTEM.—Escondido, Cal.—E. F. Tabor, District Engr., informs us that the contract for constructing the Escondido irrigation system has been awarded to I. E. Doty at the following prices, the second column being the bid of J. S. Nickerson:

Ditch Line.		
Earth, 65,000 cu. yds., at	$0.21	$0.20
Hard pan, 32,000 cu. yds., at	0.50	0.39
Loose rock, 6,500 cu. yds., at	0.48	0.65
Solid rock, 13,000, cu. yds., at	1.05	1.05
Tunnel No. 1, 320 lin. ft., at	10.50	20.00
Tunnel No. 2, 600 lin. ft., at	10.50	10.00
Lumber No. 1, 25 M. ft., at	55.00	62.00
Lumber No. 2, 25 M. ft., at	50.00	59.00
Rubble masonry, 100 cu. yds., at	8.00	12.00
Concrete masonry, 100 cu. yds., at	8.00	12.00
Reservoir Dam.		
Earth, 8,000 cu. yds., at	0.30	0.35
Rock, 250 cu. yds., at	1.10	1.35
Rock fill, 31,000 cu. yds., at	1.50	1.50
Rubble masonry, 1,000 cu. yds., at	8.00	7.75
Brick masonry, 100 cu. yds., at	8.00	8.00
Brick laid in asphalt, 350 cu. yds., at	8.00	12.00
Concrete masonry, 1,500 cu. yds., at	8.00	7.25
Dry stone masonry, 6,000 cu. yds., at	3.75	4.35
Redwood lumber, 137 M. ft., at	50.00	42.00
Distributing System.		
Earth, 46,000 cu. yds., at	0.21	....
Hard pan, 8,700 cu. yds., at	0.50	....
Loose rock, 2,000 cu. yds., at	0.48	....
Solid rock, 5,800 cu. yds., at	1.05	....
Concrete masonry, 100 cu. yds., at	8.00	....
Lumber, No. 1, 5 M. ft., per M	55.00	....
Lumber, No. 2, 5 M. ft., per M	50.00	....

The estimated cost of pipe and fittings is placed at $37,096 and the total amounts, excepting pipe, ranged as follows: I. E. Doty, $161,850 to $177,965; J. S. Nickerson, $168,557 to $185,042, according to plan of dam. The $250,000 of bonds were sold to Mr. Doty at 91 cts.

PIPE.—Orrville, O.—Bids for furnishing 4 to 10-in. cast iron pipe for the proposed water-works ranged from $17.55 to $21.50 per ton. Engr., Alexander Potter, New York.

ELECTRICAL CONDUITS.—St. Louis, Mo.—Andrew J. O'Reilly, Cy. Electrician, is preparing plans and specifications for a conduit system in several streets, for the subway commission.

IRON CASTINGS.—Cambridge, Mass.—Bids are asked until April 4 for furnishing about 20,700 lbs. of iron castings for the sewer department. L. M. Hastings, Cy. Engr.

RACE TRACK.—San Francisco, Cal.—A new racing association has been formed by Alex. and Joe Ullman, Ed. Corrigan, M. F. Dwyer, and others, and will build one of the finest tracks in the country, according to press reports; capital stock, $400,000.

EXCAVATION AND MASONRY.—Cincinnati, O.—Bids are asked until April 24 for excavation and foundation masonry for main structure of proposed new university buildings. Archs., Samuel Hannaford & Sons. Jas. M. Robinson, Mem. Com., city hall.

Brookline, Mass.—Bids are asked until April 4 for excavation and foundations for a high school building. Geo. F. Joyce, Secy.

INDUSTRIAL NOTES.

THE GENERAL ELECTRIC CO., of Schenectady, N. Y., has an order for dynamos for the new plant of the Pittsburg Reduction Co. at Niagara Falls.

THE SOUTH PITTSBURG PIPE WORKS, of South Pittsburg, Tenn., are reported as running two pipe pits and arranging to start the third pit. They are employing 250 to 300 men and melting 50 to 60 tons of iron per day.

THE CANADIAN LOCOMOTIVE & ENGINE WORKS, of Kingston, Ont., have built three heavy ten-wheel freight engines for the Intercolonial Ry., and are building two passenger engines and six boilers. boilers.

THE MANHATTAN GENERAL CONSTRUCTION CO., whose offices are at 50 Broadway, New York, and Equitable Building, Baltimore, Md., has been appointed by the Buckeye Electric Co. its sole agent for New York and vicinity and Baltimore and vicinity.

NEW COMPANIES.—Kansas City Steel & Iron Works, Kansas City, Mo.; $350,000; F. B. Johnson, J. R. Cline, and S. H. Springer.——Chicago Hydraulic Co., Chicago., Ill.; $100,000; E. J. Wight, W. H. Dunn, and M. Vanlandingham.——Seymour Power Wheel Co., Chicago, Ill.; $10,000,000; J. P. Maxwell, W. H. Jacobs and E. D. Walker.——Buffalo Dredging Co., Buffalo, N. Y.; $50,000; C. E. Williams, P. B. McNaughton and F. C. Hibbard.

METAL MARKET PRICES.

LEAD.—New York: 3.45 to 3.5 cts. Chicago: 3.25 cts. St. Louis: 3.2 to 3.25 cts.

NAILS.—Pittsburg: $1 to $1.05 for wire and 95 cts. to $1 for cut at mill.

FOUNDRY PIG IRON.—New York: $12 to $14. Pittsburg: $10.50 to $11.75. Chicago: $10.75 to $12.75.

TRACK MATERIAL.—New York: angle bars, 1.25 to 1.4 cts.; spikes, 1.65 to 1.8 cts.; track bolts, 2 to 2.3 cts. with square and 2.2 to 2.5 cts. with hexagon nuts. Chicago: angle bars, 1.4 cts.; spikes, 1.75 to 1.8 cts., track bolts, 2.4 to 2.45 cts. with hexagon nuts.

RAILS.—New York: $24 to $25 at eastern mills and at tidewater; old rails, $12 for iron and $10 for steel; light rails, $24 to $27; girder rails, $24 to $24.50. Pittsburg: $24 for standard sections. Chicago: $25 to $27; old rails, $10 for iron and $9 to $10 for steel.

STRUCTURAL MATERIAL.—New York: beams, 1.3 to 1.5 cts.; channels, 1.3 to 1.5 cts.; angles, 1.2 to 1.35 cts.; tees, 1.4 to 1.6 cts.; universal mill plates, 1.15 to 1.35 cts.; steel plates, 1.2 to 1.3 cts. for tank, 1.35 to 1.4 cts. for shell, 1.55 to 1.6 cts. for flange, 1.75 to 2 cts. for firebox. Pittsburg: beams, 1.15 to 1.25 cts.; channels, 1.15 to 1.25 cts.; angles, 1.15 to 1.25 cts., tees, 1.35 to 1.4 cts.; universal mill plates, 1.15 to 1.25 cts.; steel plates, 1.1 to 1.2 cts. for tank, 1.3 to 1.4 cts. for shell, 1.5 to 1.6 cts. for flange, 1.75 to 4 cts. for firebox. Chicago: beams, 1.4 to 1.45 cts.; channels, 1.4 to 1.45 cts.; angles, 1.35 to 1.45 cts.; tees, 1.5 to 1.6 cts.; universal plates, 1.4 to 1.5 cts.; steel plates, 1.35 to 1.45 cts. for tank, 1.7 to 1.8 cts. for shell, 1.8 to 1.9 cts. for flange, 2 to 5 cts. for firebox.

NOTICE TO CONTRACTORS.

MASONRY DAM, WATERBURY, CONN.

Sealed proposals for the construction of a Masonry Dam, Gate Chamber, Gate Houses and other appurtenances, on the West Branch of the Naugatuck River, in the Towns of Watertown and Thomaston, Litchfield County, Conn., will be received by the Committee on an Additional Water Supply of the City of Waterbury, at the office of the Mayor of said city, City Hall, until 8 o'clock p. m. of the 6th day of April, 1894, at which time and place they will be publicly opened and read.

Bidders are required to state in their proposals their names and places of residence. Each proposal shall be signed by the bidder or bidders making the same, and accompanied by a bond of Two Thousand Dollars ($2,000) conditioned for the execution of the contract within the time specified in this notice, in case the bid be accepted.

A certified check for Two Thousand Dollars ($2,000) payable to the order of The City of Waterbury and deposited with the City Clerk of Waterbury, must accompany this bond. Blank forms for the bond will be furnished by the Engineer.

The person or persons to whom the contract may be awarded will be required to attend at this office with the sureties offered by him or them and execute the contract within ten days from the date of the award, and in case of failure or neglect so to do he or they will be considered to have abandoned it and as in default to The City of Waterbury.

The amount of the bond required with the contract will be equal to twenty (20) per cent. of the total contract price.

The sureties required on the contract bond must be residents of the town of Waterbury, owning sufficient real estate within the limits of said town, or some surety company authorized by law to do such business within the state of Connecticut.

The right to reject any or all the proposals is reserved by said Committee, if deemed for the interest of the city.

The Dam is in general to be built of Rubble Masonry. It will be about 60 feet high at its highest point, and about 400 feet in length. About 11,000 cubic yards of Rubble Masonry will be needed in the work.

The Engineer's estimate of work and materials by which the bids will be tested will be furnished with the blank form of proposals.

The quantities are to be considered as only approximate and given merely as a basis of comparison. The Committee expressly reserves the right of increasing or diminishing the same as may be deemed necessary by the Engineer.

Specifications, blank forms and all available information will be furnished to intending bidders calling in person at the office of the Engineer.

The proposals must be made on blank forms furnished by the Engineer, and all proposals will be considered as informal which are not in all respects in conformity with this notice.

By order of the Committee on an Additional Water Supply. R. A. CAIRNS,
City Engineer.

Office, Room 24, Bohl's Building, 65 Bank Street, Waterbury, Conn. 12-2t

VILLAGE OF CORTLAND:

PUBLIC SEWERAGE.

Sealed proposals will be received by the Board of Sewer Commissioners of the Village of Cortland, N. Y., at their office in Keator Block, in said Village, until Thursday, the 12th day of April, 1894, at 7:30 o'clock P. M. (at which time such proposals will be opened), for constructing and completing about 1½ miles of pipe sewer in said Village, including the necessary lamp-holes, manholes and flush tanks, and furnishing all materials therefor.

Plans, profiles, requirements of proposals and specifications are on file in the office of said Commissioners at Cortland, N. Y.

Certified check $500 is required with each bid as a guaranty that contract will be executed in case of award.

The Sewer Commissioners reserve the right to reject any or all bids. Printed blanks will be furnished on application to the clerk.

FRED. HATCH, Clerk,
S. S. KNOX, Cortland, N. Y.
Pres. of Board of Sewer Com'rs,
12-2t Cortland, N Y.

PUMPING PLANT CONCORDIA, KAN

The City of Concordia, Kansas, wants a 60-horse power boiler, feedwater heater with all attachments, compound duplex pump 1,000,000 gal. capacity and ten tubular wells 6" diam. with connections.

Bids close April 9th, 1894.

Plans and specifications can be seen at the office of W. Kiersted, room 58, Waterworks Building, Kansas City, Mo., or with the undersigned. J. H. TYNER,
12-2t City Clerk.

UTICA PIPE FOUNDRY CO.

CAST IRON PIPE AND SPECIALS FOR WATER AND GAS.

Also flanged Pipe and Fittings, Hydrants, Gates, Pig Lead, etc. CHAS. MILLAR & SON, Selling Agents, Utica., N. Y. Manufacturers of Lead Pipe and Plumbers' Materials. Wholesale Eastern Agents Akron Vitrified Sewer Pipe.

FOR Best Results USE THE WARREN FILTER,

—MANUFACTURED BY—

CUMBERLAND MFG. CO., Boston, Mass.

NOTICE TO CONTRACTORS.

WINCHESTER, VA., WATER-WORKS.

Sealed proposals will be received at the office of L. G. Hollis, clerk, until noon, Tuesday, April 3, 1894, for furnishing all material and performing all labor necessary for the construction of a system of water-works for that city.

The work to be done includes the supply and construction of

A Service Reservoir.

Two Compound Duplex Pumping Engines of a capacity of 750,000 gallons each.

Two 50-HP. Boilers.

A Pumping Station.

625 tons of 4-in., 6-in., 8-in. and 10-in. cast iron pipe.

6 tons of special castings.

35 fire hydrants.

36 stop valves.

The laying of six miles of main.

Each proposal must be accompanied by a certified check for $250 payable to the city of Winchester, Va.

Plans can be seen and specifications and forms of contract secured on and after Monday, March 19, by applying to L. G. Hollis, clerk, or at the offices of the engineer, 137 Broadway, New York, and 700 Lewis Block, Pittsburgh, Pa.

C. E. HOOVER,
Chairman Water-Works Committee.
ALEXANDER POTTER,
Engineer. 11-4t

PROPOSALS

FOR CAST IRON PIPE AND SPECIAL CASTINGS.

Sealed proposals will be received at the office of the Syracuse Water Board, City Hall, Syracuse, N. Y., until 2:30 o'clock p. m. of the 6th day of April, 1894, for furnishing and delivering on board platform railway cars, in the city of Syracuse, about 3,675 tons of straight pipe and about 345,000 lbs. of special castings.

The manufacture and delivery of the pipes will be divided into three separate parcels or sections, as follows:

Section A.

30 tons of 24-inch pipe.
1,400 " 20 "
750 " 16 "
207,000 lbs. of special castings for 16, 20 and 24-inch pipe.

Section B.

250 tons of 12-inch pipe.
525 " 10 "
75,000 lbs. of special castings for 10 and 12-inch pipe.

Section C.

500 tons of 8-inch pipe.
250 " 6 "
2 " 4 "
70,000 lbs. of special castings for 4, 6 and 8-inch pipe.

The Syracuse Water Board reserve the right to award the work to three different parties, or to award two or three sections to one party as they may deem best for the interests of the city of Syracuse.

The entire delivery must be completed on or before the 15th day of July, 1894.

Blank forms of contract, specifications, bonds, conditions and proposals can be obained at the Engineer's office of the Syracuse Water Board, 510 Bastable Block, in said city, on application.

Proposals should be indorsed "Tenders for Water Pipe," and be addressed to James B. Brooks, Secretary Syracuse Water Board, Syracuse, N. Y.

W. R. HILL,
Chief Engineer.
March 19, 1894. 12 2t

Chicago Office 915 Chamber of Commerce.

COLUMBUS SEWER PIPE Co. COLUMBUS, OHIO.

WRITE FOR PRICES.

Smoothness of motion, absolute safety and high speed are among the good qualities possessed by OTIS ELEVATORS. They are built by Otis Brothers & Co 38 Park Row, New York.

NOTICE TO CONTRACTORS.

IRRIGATION WORKS, EL PASO, TEX.

Sealed bids will be received at the office of the Rio Grande Dam and Irrigation Co., El Paso, Texas, from date till April 15th, 1894, for the construction of dams and canals. Apply to the Secretary for full information.

EDWIN C. ROBERTS, President.
E. V. BERRIEN, Secretary.
El Paso, Texas, March 15th, 1894. 12-5

NOTICE TO SEWER CONTRACTORS.

Sealed proposals for building about 1½ miles of brick and 4 miles of pipe sewer on Sections 9 and 10 of the Newton Sewer System will be received by the Sewer Committee of the City of Newton, Commonwealth of Massachusetts at the office of the City Engineer, City Hall West Newton, Mass., until Thursday, April 5th, 1894, at 12 o'clock noon. The award of the contract, if awarded, will be made as soon thereafter as practicable.

All proposals must be on blank forms furnished by the City, and accompanied by a certified check for $500 drawn on some National Bank of Newton or Boston, and made payable to the City Treasurer of the City of Newton.

Some of the approximate quantities for the Sections are as follows:

	Section 9.	Section 10.
24" × 36" brick sewer..	7,400 l. ft.	.....
10" to 18" pipe sewer...	.....	6,700 l. ft.
8" pipe sewer..	6,400 l. ft.	8,000 l. ft.
Cu. yds. of brick work.	2,200	200
Total excavation various depths.....	36,000 cu. yds.	18,000 cu. yds

Bricks, pipe, cement and ironwork will be furnished by the City. Plans may be seen, specifications and forms of contract and proposals may be obtained, at the office of the City Engineer. Each bidder is required to make a statement indicating what sewer work he has done, and to give references that will enable the Committee to judge of his business standing, and no bid will be received in case the bidder has not looked the work over on the ground. The Committee reserve the right to award but one section to a bidder, and also to reject any and all bids if they deem it to the interests of the City of Newton so to do.

H. D. WOODS, City Engineer. HENRY H. HUNT, Chairman. 11-3t

STANDARD RESERVOIR AND TIDE GAUGE.

FOR USE ON RESERVOIRS, HARBORS, RIVERS, IRRIGATION CANALS, ETC.

The apparatus is small, compact, simple in adjustment, easily set up. It plots automatically a continuous curve for one month, one week, or one day, as may be required. Has been used for several years on some of the Principal Reservoirs and Harbors of the United States and Mexico. Prices greatly reduced.

For circulars and information write to

STANDARD GAUGE CO., No. 24 Haven Bldg., Buffalo, N. Y.

PROPOSALS FOR EXCAVATING.

SIXTH LETTING.

Sanitary District of Chicago.

TO CONTRACTORS.

Sealed proposals addressed to the Board of Trustees of the Sanitary District of Chicago and indorsed "Proposals for Excavating a Portion of the Main Drainage Channel" will be received by the Clerk of the said Sanitary District at Room H, Rialto Building, Chicago, Ill., until 12 m. (standard time) of Wednesday, the 18th day of April, 1894, and will be publicly opened by the said Board of Trustees at the regular meeting held that day, or at a special meeting called for that purpose.

The work for which the said tenders are invited is the excavation of that portion of the main drainage channel for the said Sanitary District, known as contract section One (1), extending from station 733 to station 800, and consists in all of about 459,724 cubic yards of rock, of about 1,662,476 cubic yards of earth, the building of 60,188 cubic yards of rubble wall, and 1,154 square yards of slope paving; and further, for the excavation of that portion of the said main drainage channel, known as contract sections N and O, extending from station 154 + 23 to station 38 + 89, consisting in all of 2,552,732 cubic yards of earth excavation.

Each of said sections will be treated as a separate contract in canvassing proposals and making awards. As all awards will be made by individual sections, each bidder must make prices for each section separate and distinct from every other.

Each proposal for each section to be accompanied by a certified check or cash to the amount of $5,000.

All certified checks to be drawn on some responsible bank doing business in the city of Chicago and be made payable to the order of the Clerk of the Sanitary District of Chicago. Said amount of $5,000 to accompany each bid for each of the respective sections will be held by the Sanitary District until all of said proposals have been canvassed and contracts awarded and signed, the return of said check or cash to the bidder to whom said work shall have been awarded being conditioned upon his appearing within ten days after notice of such award being given, with bondsmen and executing a contract with the Sanitary District for said work so awarded, and giving a bond satisfactory to the Board of Trustees for the fulfillment of the same in the amount of $100,000 for section 1, and $75,000 each for sections N and O.

All proposals must be made upon the blank forms furnished by the Sanitary District and must give the price for each separate item of work.

The bids will be compared on the basis of the Engineer's approximate estimate of quantities, which will be furnished with copies of the specifications.

No proposal will be considered unless the party making it shall furnish evidence satisfactory to the Board of Trustees of his ability to do the work, and that he has the necessary pecuniary resources to fulfill the conditions of the contract, provided such contract shall be awarded him.

Bidders are required to state in their proposals their individual names and places of residence in full.

Specifications and plans may be seen at the office of the Chief Engineer, Rialto Building, Chicago, Ill.

The said Board of Trustees reserves the right to reject any and all bids.

THE SANITARY DISTRICT OF CHICAGO,
By FRANK WENTER,
President of Its Board of Trustees
Attest: THOMAS F. JUDGE, Clerk.
Chicago, Ill., Feb. 16, 1894. 8-8t

RECEIVER'S SALE

Structural Iron Works.

BIDS INVITED.

The entire plant, fully equipped and ready for immediate operation, of the Riverside Bridge & Iron Works, situated at Paterson, N. J. (16 miles from New York City), and admirably located on the main line of the N. Y., L. E. & W. R. R., with switch connection; area nearly 30 c. t. lots, plenty of skilled labor, strikes never have occurred, facilities for handling the heaviest as well as light work—will be sold at a great sacrifice and on easy terms. A RARE OPPORTUNITY to embark in a business with little capital that promises great results, considering the low price of iron and cheapness of capital.

Address for full particulars,

J. ALBERT VAN WINKLE,
Receiver, Paterson, N. J.
P. O. Box 34.

N. B.—Remnants of stock of material, consisting of Shapes, Bars, Rivets, Bolts, &c., are offered for sale. Stock list can be had on application to Receiver. 6-tf

Office of Baltimore & Cumberland Railway Company,
Hancock, Md., March 5, 1894.

To Railway Contractors:

Sealed proposals will be received at the office of the undersigned, at Hancock, Md., until 12 o'clock noon, Saturday, March 31 inst., for the Graduation, Masonry and Tunneling of the Baltimore & Cumberland Railway, from Cumberland to Hagerstown, a distance of 78.8 miles. Plans, profiles, quantities, specifications and forms of proposal can be seen and obtained at the office at Hancock on and after the 15th inst. The company does not bind itself to accept the lowest or any bid.

CHAUNCEY IVES, Chief Engineer.
10-4t

NOTICE TO SEWER CONTRACTORS.

Sealed proposals for constructing Section 8 of the Brockton Sewerage System will be received by the Sewerage Commissioners of the City of Brockton, Mass., until 10 o'clock A. M. on Monday, April 9th, 1894, at their office, Home Bank Block, Brockton, Mass.

Each proposal must be made on the blank forms furnished by the Commissioners, and be accompanied by a certified check for the sum of $500.

The Engineer's estimate of work to be done is as follows:

Trenching and laying 1,950 linear feet of 22 × 33-in. egg shape brick sewer.

Trenching and laying 13,600 linear feet of pipe sewers, varying in size from 6 ins. to 20 ins.

Trenching and laying 15,420 linear feet of pipe for underdrain, varying in size from 5 ins. to 10 ins.

Plans can be seen and specifications and forms of contract obtained at the above office.

The right to reject any and all bids is expressly reserved.

A. C. THOMPSON,
W. L. DOUGLAS,
H. A. MONK,
Sewerage Commissioners.

F. HERBERT SNOW, City Engineer. 13-1t

THE QUEBEC CENTRAL RAILWAY.

NOTICE TO CONTRACTORS.

The undersigned will receive tenders up to April 10 for the grading and other works connected with the building of 50 miles (in sections of 2 to 10 miles) of the Tring-Megantic branch of the above-mentioned railway.

Plans, profiles and specifications may be seen at the office of the contractors, where forms of tenders and all other information may be obtained. HOLT & LUKES.

Sherbrooke, P. Q., Canada, March 13, 1894.
13-2t

PROPOSALS FOR PUMPING ENGINE AND BOILERS.

Office of the Commissioners D. C.,
Washington, D. C., March 15, 1894.

Sealed proposals will be received at this office until 2 o'clock p. m., April 14th, 1894, for furnishing a pumping engine and boilers.

Specifications and blank forms of proposals may be obtained at this office. J. W. Ross, Geo. Truesdell, Chas. F. Powell, Commissioners D. C. 12-3t

PROPOSALS FOR PORTLAND CEMENT.—U. S. Engineer Office, Montgomery, Ala., March 12, 1894.—Sealed proposals, in triplicate, for furnishing and delivering, at Wetumpka, Ala., 10,000 barrels, more or less, of Portland Cement, will be received at this office until 12 o'clock noon, April 12, 1894, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. F. A. MAHAN, Captain Corps of Engineers, U. S. A. 11-4t

U. S. ENGINEER OFFICE, 2258 WABASH Avenue, Chicago, Ill., March 15, 1894.—Sealed proposals for the design, manufacture and erection of the superstructures of one metal single track railway swing bridge, and one metal highway swing bridge, at Milan, Ill., will be received at this office until 12 M. central time, Tuesday, May 1, 1894, and then publicly opened. Specifications, blank forms and all available information will be furnished on application to this office.

W. L. MARSHALL,
12-4t Capt. Corps of Engineers.

U. S. ENGINEER OFFICE, 537 CONGRESS Street, Portland, Maine, March 19, 1894.—Sealed proposals for dredging in Penobscot River, Maine, will be received at this office until 3 p. m. on Saturday, April 21, 1894, and then publicly opened. Specifications, blank forms and all available information will be furnished on application to this office. PETER C. HAINS, Lieut.-Colonel of Engineers.
13-4t

U. S. ENGINEER OFFICE, 537 CONGRESS Street, Portland, Maine, March 19, 1894.—Sealed proposals for dredging in Portland Harbor, Me., will be received at this office until 3 P. M. on Saturday, April 21, 1894, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office.

PETER C. HAINS,
14-3t Lieu.-Colonel of Engineers.

TO SEWER CONTRACTORS.

Sealed bids will be received at the office of the Commissioner of Public Works of Peoria, Ill., until 2 o'clock p. m., April 6th, 1894, for the construction of sewers in the Walnut St. Sewer District, consisting approximately of the following quantities of work:

193 feet	3′ 0″ × 4′ 6″	brick sewer.		
351 "	2′ 10″ × 4′ 3″	"	"	
165 "	2′ 4″ × 3′ 6″	"	"	
412 "	2′ 3″ × 3′ 4½″	"	"	
456 "	2′ 1″ × 3′ 1½″	"	"	
196 "	2′ 0″ × 3′	"	"	
287 "	18″	pipe sewer.		
1,341 "	14″	"	"	
3,261 "	12″	"	"	
2,264 "	10″	"	"	
16,622 "	8″	"	"	
1,650 "	6″	"	"	

57 manholes.
35 flush tanks.
17 storm water inlets.
12 independent lamp holes.
26 cu. yds. outfall stone abutment.

Bids must be accompanied by a certified check for $2,000.

For information, form of contract, specifications, etc., apply to the City Engineer.

ISAAC TAYLOR
Commissioner of Public Works.
JACOB A. HARMAN, City Engineer.
Peoria, Ill., March 5th, 1894. 11-3t

NOTICE TO RAILWAY CONTRACTORS.

Sealed proposals will be received by the Engineer until Saturday, the 14th day of April next, at one o'clock p. m., for furnishing all the material except the rails and ties and building about 2¼ miles of track for the Highland St. Railway Co. Specifications may be seen at the residence of L. F. Thayer in Westfield, Mass. The company reserves the right to reject any and all bids.

HIGHLAND ST. RAILWAY CO., Westfield, Mass. 13-1t R. D. Gillett, Clerk.

NOTICE TO CONTRACTORS.

KITTANNING, PA., SEWERS.

Sealed proposals will be received by the President of the Borough Council until noon Monday, April 16th, 1894, for furnishing all material and performing all labor necessary for the construction of a system of sewers for Kittanning.

The work which is to be done includes the supply and construction of

21,225 feet of	8″	vitrified pipe.
1,212 "	10″	" "
1,425 "	12″	" "
2,625 "	15″	" "
884 "	20″	" "
500 "	24″	" "
900 "	30″	" "
884 "	42″	Brick sewer.
485 "	2′ 4″ × 3′ 6″	Brick sewer.
515 "	2′ 10″ × 4′ 3″	" "
700 "	16″	cast iron pipe.
1,000 "		Drain tile.

23 Flush tanks.
66 Manholes.
2 Lampholes.
88 Catch basins.
250 Cubic yards stone masonry.

Each proposal must be accompanied by a certified check for $500. The Borough Council reserves the right to reject any and all bids. Plans can be seen and specifications and forms of proposal secured at the Council Chamber, or at the offices of the Engineers, 137 Broadway, New York, and 700-701 Lewis Block, Pittsburg, Pa.

G. R. BROWNE, President Council.
POTTER & FOLWELL, Engineers. 13-3t

MERIDIAN, MISS., SEWERS.

Sealed proposals indorsed "Proposals for Constructing Sewers," and addressed to I. A. Mooser, City Clerk, will be received by the Mayor and Boards of Councilmen and Aldermen of the City of Meridian, Miss., at the City Clerk's office, up to Tuesday, May 1, 1894, until 12 o'clock noon, for the construction of a system of sewerage.

The work comprises about 17 miles of vitrified pipe sewers, about one mile of brick sewer, 304 manholes, brick masonry, etc., etc.

The work to be done in accordance with plans and specifications on file in the office of the City Engineer, where blank forms of proposals and contract may be had.

The right to reject any or all bids is reserved.

I. A. MOOSER,
City Clerk.
N. M. BRANDON,
City Engineer.
Meridian, Miss., March 19, 1894. 13-4t

PROPOSALS FOR TRENCHING AND PIPE LAYING.

Proposals for Trenching and Pipe Laying will be received at the office of the Syracuse Water Board, City Hall, Syracuse, N. Y., until 2:30 o'clock P. M. of Friday, April 13th, 1894, for trenching and laying cast-iron water pipes and special castings, setting gates and hydrants and other fixtures, refilling trenches and other work connected therewith in the City of Syracuse, as follows:

2,500 lineal feet of	36-inch	main.		
3,00 "	"	"	30 "	"
5,100 "	"	"	24 "	"
9,6 0 "	"	"	20 "	"
5,800 "	"	"	16 "	"
1,200 "	"	"	12 "	"
15,900 "	"	"	10 "	"
10,300 "	"	"	8 "	"
9,000 "	"	"	6 "	"
100 "	"	"	4 "	"

Work must be commenced within ten days after the execution of the contract, and be fully completed on or before the first day of October, 1894.

Each bid must be accompanied by a certified check for $1,000 (one thousand dollars) on a National or State Bank of good standing in the city of New York or the city of Syracuse made payable to the President and Secretary to the Syracuse Water Board, to be held by the said Board under the conditions stated in the forms of contract.

The successful bidder will be required to enter into a contract and furnish the required surety in the sum of $8,000 (eight thousand dollars) within five days after notice of award.

Blank forms of contract, proposals, bonds and specifications can be obtained at the Engineer's office of the Syracuse Water Board, 510 Bastable Block, in said city, on application.

Proposals should be indorsed "Tenders for Trenching and Pipe Laying," and be addressed to James B. Brooks, Secretary Syracuse Water Board, Syracuse, N. Y.

W. R. HILL, Chief Engineer.
March 21st, 1894. 13-2t

NOTICE TO WATER WORKS CONTRACTORS.

Sealed proposals will be received for the construction of a complete system of water works for the City of Poplar Bluff, Mo., until 9 o'clock p. m., Monday, April 16 h, 1894.

Plans and specifications may be seen at the clerk's office in Poplar Bluff, Mo.

Bids will be received for the whole or a part of the system. Right to reject any or all bids reserved by council. A certified check for $500 must accompany all bids.

J. B. REYNOLDS, Clerk of Poplar Bluff.
ISAAC A. SMITH, Consulting Engineer, St. Louis. 13-2t

BOOKS PUBLISHED BY Engineering News Publishing Co.

COMPARATIVE MERITS OF VARIOUS SYSTEMS OF CAR LIGHTING.

A full illustrated description of all the methods of railway car lighting now in use—oil, gas, gasoline and electricity—with particulars of the comparative cost, comparative safety, comparative convenience and comparative illuminating power.

303 pages, cloth bound, 5×6 ins., with 77 illustrations and complete index. Cloth, 303 pp. $1.00.

COST OF LAYING WATER PIPE.
By C. D. Barstow.

Comprises valuable tables for estimating cost of laying water pipe. Paper (pamphlet form) 10c.

DRAINAGE TABLES.
By G. H. Johnson, C. E.

Gives the necessary diameters of pipes for the discharge of given quantities under given heads, etc.; for the use of railway and city engineers. Paper; 25c.

ECONOMIC THEORY OF THE LOCATION OF RAILWAYS.
By A. M. Wellington, C. E.

An analysis of the conditions controlling the laying out of railways to effect the most judicious expenditure of capital. Fifth edition, cloth, 980 pp. $5.00.

ENGINEER'S FIELDBOOK.
By C. S. Cross, C. E.

Includes also much valuable information on railroad surveying and construction by Prof. C. A. Smith, and W. F. Shunk, and special chapters on Topography and Staking-out Problems, Transition or easement curves, Earthwork and Masonry, Culverts and Bridges, etc. Compiled and edited by George H. Frost, C. E. Fourth edition. Cloth, 166 pp. $1.00.

EXPLOSIVES AND THEIR COMPOSITION.
By W. C. Foster.

Contains list of explosives which have been either suggested or employed as blasting agents, with descriptions of their composition. Paper. 20c.

GENERAL INDEX TO ENGINEERING NEWS, 1874-1890.

This index includes the principal papers and articles which have appeared in Engineering News from the issue of the first number in 1874 to the end of the year 1890, and thus comprises a reference list to nearly all of the important works relating to civil engineering and its allied professions. Cloth. $1.00.

MANUAL OF AMERICAN WATER-WORKS.
Compiled from Special Returns.
Edited by M. N. Baker, Ph. B.
First Edition, 1888. $3.00.

Contains the History, Details of Construction, Source and Mode of Supply, Pumping Machinery, Distribution, Consumption, Pressure, Hydrant Rental, Revenue and Expenses, Cost and Debt, etc., of every Water-Works in the United States and Canada; with Summaries for each State and Group of States, and Directory of Water-Work Officials, Engineers and Contractors.

Second Edition, 1889-90, out of print.
Third Edition, 1889-90. $3.00.

Omits Historical and Technical Matter published in Former Editions, but contains Full Descriptions of all New Works and of Extensions of Old Works; and gives Tabulated Statistics of Many Individual Works, showing Growth from year to year. Much space is devoted to Tracing the Relation between Water Consumption and the Use of Meters, and to Discussion of Water-Works Franchises and Government. Valuable Summaries are given showing the Growth of Works by Increase in Number of Works, in Population Supplied and according to ownership, *i. e.*, whether works are owned by municipality or by a private company.

Fourth Edition will be published in 1896.

PILES AND PILE DRIVING.
Edited by A. M. Wellington, C. E.

A complete, practical treatise on the best methods, with special reference to the calculation of safe loads. Paper covers, 145 pp. $1.00.

PLAT AND PROFILE BOOK for Civil Engineers and Contractors.
By H. F. Dunham.

Arranged in pocket-book form, convenient for mapping to scale (400 ft. per inch) and recording notes of alignment, right of way, reference points, bench marks, etc., which in the work of construction are no less important than the profile itself. Leather, oblong. $1.00.

RAILWAY SURVEYS AND RESURVEYS.
By Hosea Paul.
Pamphlet. 10c.

ROAD MAKING AND MAINTENANCE.
By C. Herschel, C. E., and E. P. North, C. E.

Two papers on the Science of Roadmaking and Construction and Maintenance of Roads, containing more condensed and valuable information on a subject now attracting widespread attention than any similar publication of which we have knowledge. New edition bound in paper covers, and price reduced from $1.50 to 50c.

TABLES FOR ESTIMATING COST OF LAYING CAST IRON WATER-PIPE.
By E. B. Weston, C. E.
Paper (pamphlet form), 10c.

TABLES OF EQUIVALENTS of Metrical and English Measures, Weights, etc: areas of right-angled triangles, with slopes of ¼ : 1 to 4 : 1; frogs and switches for various gages, etc. By J. McGee, C. E. Boards, 10c.

TABLES OF SQUARES.
By E. E. Buchanan.

Containing the square of every foot, inch, and sixteenth of an inch between one-sixteenth of an inch and fifty feet. For engineers and calculators. Cloth, 102 pp. $2.00.

Continued on page XVIII.